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References:

Raman, C. V. (1949) The theory of the Christiansen experiment. *Proc. Indian Acad. Sci.*, A, 29: 381-90.

Sahni, B. (1936a) Wegener's theory of continental drift in the light of Palaeobotanical evidence. *J. Indian bot. Soc.*, 15: 31-32.

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CONTENTS

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Adenosine Triphosphate Breakdown by Liver Extracts

BY

H. C. FRIEDMANN* AND P. S. SARMA
University Biochemical Laboratory, Madras-25

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ABSTRACT

A comparative study on ATP breakdown by liver extracts of rat, rabbit, guinea pig, monkey, ox, pig, pigeon and frog was undertaken. Estimations of liberated phosphate and ammonia as well as Thunberg experiments showed breakdown of ATP into its constituents. The importance of paying attention to species differences was stressed. Rat liver extract was found to be the most active. The dephosphorylation and deaminating enzymes were shown to be very stable. Considerable amounts of ammonia were liberated from the ATP only by extracts showing high dephosphorylating power. This was circumstantial evidence that muscle adenylic acid is preferentially deaminated by such extracts at the nucleoside and not the nucleotide stage. Frog provided an exception. Large variation in xanthine oxidase activity in liver extracts of different species was detected. Frog liver contains no xanthine ovidase. The significance of these findings is discussed.

Before the fundamental importance of the degradation of adenosine triphosphate (ATP) in muscle was recognised, liver preparations were used for most enzymological work on ATP breakdown. A perusal of the literature reveals no agreement concerning the extent of this breakdown by such preparations. Thus, after Jacobsen (1931) had demonstrated the specificity of liver adenylpyrophosphatase, Barrenscheen and Lang (1932), using cell-free liver centrifiugates from guinea pig and from rabbit reported (i) liberation of only two of the three phosphate groups of ATP, (ii) only a very slight dephosphorylation of muscle adenylic acid, and (iii) no ammonia formation in the pH range 5·5—9·0. They

*Present address: Biochemistry Department, Madras Medical College, Madras-3.

This paper represents part of a thesis by one of us (H.C.F.) approved for the M.Sc. degree of the University of Madras.

isolated the adenylic acid formed. Similarly Bailey (1942) working with dialysed rabbit liver extract demonstrated liberation of the two labile phosphate groups of ATP alone. Kalckar (1944) from his data appeared to consider ATP breakdown by liver extracts to cease at the stage of adenylic acid. DuBois and Potter (1943) compared the adenylpyrophosphatase activity in suspensions of ten different tissues of the rat, but as pointed out by Krishnan (1949), these workers did not determine phosphate liberation in terms of total available organic ATP phosphate, so that it is not certain whether the detached phosphate was due to apyrase activity alone. In contrast to these observations the following may be cited: Haase (1936), using rabbit and pig liver extracts obtained liberation of more than two thirds of total organic ATP phosphate, and complete dephosphorylation of muscle adenylic acid. Reis (1937) ascertained the wide distribution and specificity of 5-nucleotidase in suspensions of animal tissues, including liver. Simultaneous dephosphorylation of 5-nucleotides by the general non-specific alkaline phosphomonoesterase could not be excluded (cf. Schmidt and Thannhauser, 1943, for intestine). Species and organ differences were observed. From the data of Reis it can be seen that rat tissues showed the highest over-all activity, rabbit tissues much less. V. Euler and Skarzynski (1940) showed complete breakdown of ATP and of muscle adenylic acid by dialysed rat and rabbit liver extracts on the basis of methylene blue decolourisation in the Thunberg experiment. They had demonstrated (Adler and v. Euler, 1939) that it was the free purine (hypoxanthine), formed in the course of the enzymatic breakdown of nucleotides, which underwent dehydrogenation by the agency of xanthine oxidase present in the liver extracts (cf. Boyland and Boyland, 1935). Equal dephosphorylating activity on muscle adenylic acid in rat and rabbit liver extracts has to be deduced from the equivalent speeds of methylene blue decolourisation with muscle adenylic acid, adenosine and hypoxanthine in these two animals. The analytical work of Kerr and Seraidarian (1945) also implied complete dephosphorylation; by isolation methods they identified the constituents of the different groups of purine derivatives (nucleotide, nucleoside, free purine) formed by the autolytic breakdown of ATP in dog liver. In contrast to Barrenscheen and Lang, ammonia liberation from ATP was detected by Stoner and Green (1945), using slices, pulp or watery extracts of rat liver.

The experiments to be described in this paper were designed in an attempt to clarify some of these discrepancies. Since species

differences appeared to constitute an important factor, comparative investigations on ATP degradation by liver extracts of rat, rabbit, guinea pig, monkey, ox, pig, pigeon and frog were undertaken.

Methods

Liver Extracts. Livers were excised from animals which had been killed by a blow on the head and bled. After washing and drying the livers were ground in a porcelain mortar with 60—80 mesh acid-washed sand, extracted with twice their weight of glass-distilled water and centrifuged. The procedure was once repeated with the residue and the two centrifugates were combined. Four parts of this cell-free centrifugate thus corresponded to enzyme from one part liver. The extract was stored in the cold under toluene. (Toluene was found not to affect phosphate and ammonia liberation; cf. Meyerhof (1949) for effect of toluene on soluble apyrases). Enzyme activity was retained for at least two weeks. Dialysis was performed under toluene against running tap water at room temperature. In tests with dialysed extracts the volume corresponding to 0·4 ml. undialysed extract was used, and the quantity of extra water in the test correspondingly diminished.

ATP. Prepared from muscle of bull frogs according to Lohmann (1931), as described by Dey, Friedman and Sivaraman (1949). It was stored as barium salt. Solutions were always prepared fresh just before use in graduated 15 ml. centrifuge tubes. The solutions were obtained by adding to the suspension in water the calculated amount of N sulphuric acid, followed immediately by N sodium hydroxide to the required pH and centrifuging. The precipitated barium sulphate was not washed because of the small volumes and because these washings did not readily settle on centrifuging. On an average a quarter of the ATP was lost due to pH adjustment and probably more so due to absorption on the barium sulphate (Bailey, 1942, 1949). For the analytical work, ATP solution obtained from 3 mg. barium salt was taken per test, for the Thunberg experiments half this amount. Total P in an aliquot was determined in each case.

Buffers. Borate buffer according to Palitzsch (as described in Clark, 1928), unless otherwise stated was employed, omitting sodium chloride. This was satisfactory under the conditions employed since the pH, measured with Beckman pH meter, was not affected by addition of liver extracts and ATP solution, and had

not changed at the end of incubation. Most experiments were carried out at pH 8·2.

Procedure for Incubation. The standard test (total volume 2·2 ml.) in Pyrex test tubes consisted of 0·4 ml. liver extract (corresponding to 100 mg. liver), incubated with 0·6 ml. borate buffer (pH 8·2) and 0·7 ml. water, to which were added 0·5 ml. of separately incubated ATP solution at the beginning of experiments. Blanks contained water instead of ATP. To another series of blanks, termed controls, 0·5 ml. of ATP were added after inactivation of enzyme. The difference between control and blank gave the value of inorganic phosphate in the ATP. Enzymes were inactivated by 1 ml. N/2 hydrochloric acid, the mixture immediately diluted to 8 ml. in graduated centrifuge tubes. 4 ml. were pipetted out for phosphate estimation, the remaining half was used for ammonia estimation.

Phosphate was estimated according to Fiske and Subbarow (1925). Protein was precipitated by 1 ml. of 10% trichloracetic acid. To the clear centrifugate one washing containing ½ ml. of 10% trichloracetic acid was added. For estimation of total P in ATP a drop of nitric acid was used for final oxidation. It is necessary to stress that this drop should be added at the very start of any signs of charring or fuming, since there is otherwise the risk that the final colour developed is either a dirty, faint bluish-green or even a clear yellow, or an unstable blue which fades and changes to greenish after some time. This recalls the observations of Roe, Irish and Boyd (1926) that a yellowish compound, possibly a nitrated phenol, is formed with nitric acid. In the present work it was found that although such a yellow compound is destroyed on prolonged incineration the interference is not thereby abolished. Free nitric acid added to inorganic phosphate before addition of reagents did not produce a similar interference.

Ammonia was determined by Nesslerising after aeration, since the amounts were too small for titration. Any atmospheric ammonia was absorbed in a prefixed tube with sulphuric acid, and frothing in the tube containing the liver extract was avoided by the use of a few drops of caprylic alcohol. Milder agents such as liquid paraffin were ineffective. Initially considerable difficulty was experienced due to the production of a strong turbidity in the receiver on addition of Nessler's reagent. This was traced to the caprylic alcohol which had been carried over from the tube with liver extract. Sufficient caprylic alcohol to delay the appearance

of turbidity during the time of estimation could be conveniently removed from the receiver by a separate aeration of about three minutes. Caprylic alcohol however has no effect on the shade or intensity of the colour produced when the quantities left behind are so small that a turbidity appears only after the reading of the colour has been long completed. All estimations were done in duplicate.

Thunberg Experiments. Thunberg tubes with hollow stopper (Keilin type) were used, substrate and methylene blue in stopper, and enzyme, buffer and other substances, if any, in tube. Total volume 2·2 ml., as for the analytical work, but amount of ATP about half. Each tube contained 0·3 ml. of 1:2000 methylene blue. For xanthine solutions an amount corresponding to 3 mg. per tube was dissolved in the minimum amount of sodium hydroxide.

The amount of methylene blue used was less than that required as hydrogen acceptor of total purine in the nucleotide. This was done because (i) These experiments were designed merely to give an indication of the presence or absence of a total breakdown of ATP, and were required to give no more than comparative values of the over-all rate of breakdown of ATP by the liver extracts of different animals; (ii) decolourisation from total ATP would have taken unnecessarily long, especially in the extracts from some of the less active animals, (iii) under the conditions adopted, the time of decolourisation was found to be largely independent of the exact amount of ATP used within its range, so that the values obtained in different experiments could readily be compared with each other, while at the same time the need for a separate estimation of the exact amount of ATP present in each experiment was avoided. As the available thermostat had no transparent side the Thunberg tubes were illuminated by a strong light from above the water level and viewed by reflection in a mirror. It was found that differences in colour shade could more readily be gauged by such reflected light than by direct light. All tests were done in duplicate.

A few oxygen absorption experiments were performed, using a *Warburg manometer.*

Experimental

Definite liberation of ammonia by rat liver extract acting on ATP was established at the outset. Liver apyrase activity is known to increase with increasing pH (cf. Barrenscheen and Lang), while

the activity of adenosine deaminase falls beyond pH 7·0 (Schmidt, 1928; György and Röthler, 1927; Conway and Cooke, 1939; Ostern and Mann, 1933). There is hence no ideal reaction at which both phosphate and ammonia liberation are at an optimum. It was decided to use pH 8·2 as the fixed pH for all experiments. Ammonia did not escape under the conditions adopted, as was found by comparison with the ammonia value in an experiment performed in a stoppered Warburg vessel with two side limbs. The following constitutes a representative experiment establishing dephosphorylation and deamination of ATP:

TABLE 1.

ATP Breakdown by Dialysed and Undialysed Rat Liver Extracts

Composition of tests as described above. Total ml. 2·2 ml. Rat liver extract dialysed for 17 hours. Tests exposed for 2 hours 20 minutes. Values for 1·1 ml.

	Undialysed	Dialysed
Organic P in ATP (mg. P)	0·11466	
Liberated P	0·1626 — 0·581 = 0·1045	0·1269 — 0·0192 = 0·1077
% phosphate liberated	91·2	94·0
Amino N in ATP (mg. N)	$0{\cdot}1146 \times \frac{14}{93} = 0{\cdot}01725$	
Liberated ammonia (mg. N)	0·02611 —0·01199 = 0·01412	0·01854 — 0·00462 = 0·01392
% ammonia liberated	81·9	80·7

This experiment gave rise to a number of conclusions: (i) The comparable phosphate and ammonia values in dialysed and undialysed liver extracts proved that mechanisms significantly masking ATP dephosphorylation and deamination by transfer or reabsorption could be excluded. Correspondence between phosphate and ammonia values was observed in the majority of cases. Exceptions were: A fresh undialysed rat liver extract in which only 76% of total organic phosphate, but 89% of the available amino nitrogen was liberated. In the case of one out of four ox liver extracts tested, phosphate liberated was 68·6% of the total available, while ammonia was 91%; after dialysis the phosphate

value rose to 84·8%. A pig liver extract yielded 61·9% of total phosphate, but as much as 32% of available ammonia.

To exclude phosphorylase activity most of the experiments were performed after storage of the liver extracts in the ice chest for at least one day. According to Cori, Colowick and Cori (1938) tissue extracts (excepting muscle) lose their phosphorylating activity when kept for only one or two days in the refrigerator.

Similarly the absence of the enzyme or enzymes stabilizing phosphate with anabolised ribose could be excluded, since instability in solution has been reported (Waldvogel and Schlenk, 1947).

On statistical grounds one must always keep in mind the possibility of some dephosphorylation and further catabolism of liberated adenylic acid already before the whole sample of ATP has lost its labile phosphate. Thus even in the absence of any phosphorylating mechanisms, a total phosphate liberation of less than 66·7% need not mean that all the individual molecules of ATP have lost less than 2/3 of their total phosphorus.

(ii) The dephosphorylating and deaminating enzymes are relatively stable. In the above experiment the temperature of the tap water was 32°C in the morning and 31°C ·5 next morning. Stability of liver apyrase was recognised by Barrenscheen and Lang; it contrasts markedly with the high lability of myosin ATP-ase.

(iii) The inorganic phosphate present in the liver extracts did not inhibit phosphate liberation. This was confirmed as follows:

TABLE 2.

Ammonia Liberation in Presence of Phosphate

Composition of tests as in Table 1. For the tubes with phosphate, Na_2HPO_4 was added instead of water; it contained 1 mg. P per tube. Experiments with the Beckman pH meter had shown that Na_2HPO_4 did not affect the pH of the buffered liver extract. Exposure 80 mins. The ATP sample used contained 11·37 and 8·594% total P and total N resp. Ammonia values from total solutions given.

Experimental value in presence as well as in absence of added phosphate	..	0·03127 mg. N.
Control in both cases	..	0·01904 mg. N.
Liberated ammonia	..	0·01223 mg. N.
Total P in the ATP used per test	..	0·1302 mg. P.

$$\text{Available ammonia } 0{\cdot}1302 \times \frac{8{\cdot}594}{5 \times 11{\cdot}37} = 0{\cdot}01968 \text{ mg. N.}$$

% ammonia liberated in both cases 62·2.

In a parallel Thunberg test the decolourisation time in presence and absence of added phosphate were the same within experimental limits (16½ and 17 minutes resp.), compared to a blank time of 91 mins.

Lohmann (1928) had established that muscle ATP-ase is inhibited only by high concentrations of phosphate; thus 1% K_2HPO_4 strongly affected the enzyme, while 0·33% K_2HPO_4 did not. Barrenscheen & Lang detected a moderate inhibition to liver adenylpyrophosphatase in phosphate buffer (i.e., with larger amounts of phosphate than added in the above experiments).

Further evidence for the total breakdown of ATP by liver extracts was obtained by following oxygen absorption in the Warburg manometer. Thus in the course of 150 minutes, a sample of ATP containing 0·2658 mg. total P per vessel and with a ratio $\frac{\text{total P}}{\text{total N}}$ of $\frac{10{\cdot}78}{7{\cdot}347}$ caused an oxygen absorption of 81·1 µl. when acted upon by a five-day old rat liver extract. It may be calculated that this amount of ATP contains the equivalent of 0·3521 mg. of hypoxanthine which absorb $0{\cdot}3521 \times \frac{180}{0{\cdot}76} = 83{\cdot}4$ µl. oxygen for complete oxidation to allantoin (value of Morgan, Stewart & Hopkins, 1922-23). Animals with a lower over-all catabolic activity on ATP (guinea pig and pig, cf. below, were tested) showed no detectable oxygen absorption in the Warburg experiment, although they did decolourise methylene blue. The agreement of oxygen absorption with the theoretical amount in the case of rat liver, and the absence of such absorption in the case of guinea pig and pig were sufficient proof to indicate that the absorbed oxygen actually served to oxidise the liberated purine and not any products that might have been formed as a result of utilised phosphate bond energy.

Thunberg experiments were preferred as an indicator of total ATP breakdown since these were not only more rapid and simple

in execution but also more sensitive. A simple calculation shows that decolourisation of 0·15 mg. methylene blue (present in the 0·3 ml. of 1 : 2000 solution used in Thunberg experiments) corresponds to an oxygen absorption of only 12·3 µl., when minimum sensitivity is assumed for methylene blue reduction and maximum sensitivity for oxygen absorption.

In proof of the absence of side reactions as possibly responsible for extra methylene blue decolourisation in presence of ATP, this decolourisation was investigated using liver extracts containing no xanthine oxidase. Pigeon liver extract (fresh), known to be free from xanthine oxidase (Morgan 1926) was used Tubes containing ATP or xanthine showed the same decolourisation time as the blank (14 mins., using only 0·1 ml. of 1:2000 methylene blue solution). The conclusion that ATP brought about no other reactions involving a dehydrogenase was confirmed by similar observations made with frog liver extract, which, as found in the course of this study, lacks xanthine oxidase also.

The fact that increase in the concentration of ATP did not effect a more rapid decolourisation also proved that the observed decolourisation was actually due to oxidation of the liberated purine. If the observed methylene blue decolourisation would have had its origin in any reactions besides those of its own breakdown, dependent on the supply of phosphate bond energy, shortening of this decolourisation time could have been expected. In actual fact increase in the concentration of ATP caused a very slight but definite *prolongation* of decolourisation time. In a two day old guinea pig liver extract the times with ATP solution from 1, 1·5 and 3 mg. were 44, 47 and 49 minutes respectively, the time for the blank being more than two hours.

An ox liver extract (4 days old) was chosen to determine the *effect of varying enzyme concentration on phosphate and ammonia liberation.* In the standard test, extract corresponding to the usual 100 mg. of liver caused a phosphate liberation of 67·9% and an ammonia liberation of 32·6% in 2 hours 20 minutes. With half this amount of enzyme the phosphate value dropped to 46·3%, the ammonia to a trace; a doubling of the enzyme concentration increased the phosphate value to 90·7% and the ammonia value to 79·6%. In a dialysed monkey liver extract a doubling of the usual enzyme concentration under the same conditions as above caused an increase in liberated phosphate from 73·2 to 98·1%. It may be

mentioned that Greenstein, Carter and Chalkley (1947) observed that a doubling of enzyme concentration for a constant substrate concentration produced a considerable increase in the deamination and dephosphorylation with desoxyribonucleate and a smaller increase with ribonucleate. The reaction apparently stopped or slowed down to imperceptible rates long before total dephosphorylation and deamination at the lower enxyme concentrations had taken place. In this respect the results obtained with 3-nucleotides are similar to the results obtained with ATP.

A further proof of the total breakdown of ATP by rat liver extracts was provided by demonstrating formation of uric acid and (indirectly) of allantoin. Uric acid formation during anaerobic incubation in the presence of methylene blue as hydrogen acceptor was shown qualitatively, using the reaction of Benedict and Franke (1922). The methylene blue which reappeared on exposure to air was removed by a pinch of decolourising charcoal (B.D.H.) This was centrifuged off together with the trichloracetic acid-precipitated protein. In the blank test to which methylene blue had been similarly added there was practically no colour for uric acid formed. Only a qualitative result could be obtained, since the charcoal absorbed some of the uric acid in addition to the methylene blue. The reaction for uric acid disappeared when the anaerobically incubated mixture (with methylene blue) was subsequently exposed for 1½ hours to air with occasional shaking. The uric acid had evidently been further oxidised to allantoin.

COMPARATIVE EXPERIMENTS

(a) *Phosphate and Ammonia Liberation*: To obtain an idea of the comparative capacities for ATP breakdown, phosphate and ammonia liberations were determined in undialysed extracts of the livers of *different* animals; in most cases the phosphate liberation was also determined in the dialysed extracts. There was broad agreement between phosphate liberations by undialysed and dialysed extracts. Parallel experiments were in general run with rat liver extracts. Extracts were tested from two rabbits, two guinea pigs, one monkey (*Semnopithecus entellus* Blyth) four oxen, two pigs, two pigeons and two frogs (*Rana hexadactyla*). Values in each species excepting pig were fairly consistent. Experimental arrangements as in Table I. The results were as follows:

TABLE 3

Phosphate and Ammonia Liberation from ATP by Liver Extracts of Different Animals.

Arrangement of tests as in Table 1. The figures represent the per cent. liberation of total available phosphate and ammonia. Values in brackets refer to rat liver extracts run in parallel.

	Undialysed		Dialysed
	Phosphate	Ammonia	Phosphate
Rabbit	61·3	16·5	71·2
	(91·7)	(99·8)	
	61·9	15·3	62·6
Guinea Pig	58·0	14·7	61·4
	(94·7)	(83·8)	(90·3)
	49·2	Trace	52·8
Monkey	76·8	28·6	73·2
	(99·1)	(83·3)	
Ox	57·3	15·4	
	(100·2)	(83·3)	
	57·7	12·0	
	(94·0)	(85·7)	
	65·2	36·4	
	(98·9)	(88·8)	
	68·6	91·0	84·8
	(87·0)	(91·0)	
Pig	86·3	99·3	
	(89·2)	(101·0)	
	61·9	32·0	
Pigeon	56·8	7·4	
	55·8	8·2	
Frog	66·5	40·7	45·5
			(Ammonia 28·2)
	60·6	39·4	

From this table it will be seen that rat liver extract was among the animals tested the most active in liberating phosphate and ammonia from ATP. Pigeon and guinea pig had lowest activity, followed by rabbit and then monkey. Ox and pig showed variable

activity. The liberated ammonia was in general low when the liberated phosphate was below 67%, and relatively higher when above this level. Frog liver was exceptional: The phosphate liberated was only about 2/3 of the total available, but the ammonia values were relatively higher than in the other species. It is possible that in frog liver extract any adenylic deaminase present completes successfully with 5-nucleotidase. Dialysis caused reduction in activity to frog liver extract alone.

(b) *Thunberg Experiments*: These were carried out on the undialysed extracts. The decolourisation times in the presence of ATP as well as in the presence of xanthine were determined in each case.

TABLE 4

Decolourisation of Methylene Blue by Liver Extracts of Different Animals in the Presence of ATP and of Xanthine

The figures represent "activities" as the difference between the reciprocals of experimental and blank times. Values in brackets refer to rat liver extracts run in parallel.

	Activity with ATP		Activity with Xanthine	
Rabbit	0·37	(3·87)	3·28	(21·68)
	0·86		8·00	
	2·22		—	
Guinea Pig	3·39		5·47	
Monkey	1·09	(7·06)	14·93	(17·06)
Ox[1]	3·25		18·59	
	5·05		—	
Pig[2]	0·37		3·72	
Pigeon	—		—	
Frog	—		—	

1. This corresponds to the last two oxen in Table 3.
2. This corresponds to the first pig in Table 3.

Since there was decolourisation of methylene blue with all extracts containing xanthine oxidase, total breakdown of ATP by these extracts was proved. The low activity in ATP breakdown of the pig liver extract may be contrasted to the higher activity in

the guinea pig liver extract, although xanthine oxidase activities in these two animals were comparable. Dephosphorylation and deamination in the pig were higher than in the guinea pig. This indicates that pig liver nucleosidase was less active than that of guinea pig. Similarly comparison of values for guinea pig and rabbit would indicate higher nucleosidase activity in the former. Xanthine oxidase activities in monkey and ox were of the same order of magnitude as in the rat.

DISCUSSION

It is difficult to gauge the significance for variations of enzyme concentrations in the same organs of different animals. In the absence of more knowledge which would enable the intensity of enzyme activities to be correlated with other specific functions in the respective animals it will remain difficult if not impossible to bring these apparent irregularities into some sort of order. Two publications on the quantitative distribution of some of the enzymes here involved may be cited. Reis (1937) could not explain the wide variations of 5-nucleotidase concentration in the differenet tissues of different animals. Similarly Truszkowski & Goldmanowana (1933), working on uricase distribution, conclude that "no connection appears to exist between the distribution of uricase and the phylogenetic relationships of the animals examined". In the present experiments the activities observed with liver extracts need not give an accurate picture of the intensity and exact course of ATP degradation undergone in the intact cell. The activity in the intact cell requires histo-chemical investigations. The course of breakdown of a complex substance like ATP is merely the overall result of the action of each of the various enzymes concerned acting in bulk. Since nucleotides are enzymatically vulnerable at various points, it is possible that the breakdown 'in vivo' differs from that observed 'in vitro'. 'In vitro' we only observe the overall result of a competition between various enzyme actions (cf. Kerr and Seraidarian), while the intact cell may resort to a finely balanced breakdown, integrated with other metabolic activites. Insufficient attention has also been paid to the variation in physical state or anchorage of the same enzyme even in the same tissue of different animals. Thus for example Willstätter (1933) reported that kidney histozyme is easily soluble in dog kidney, insoluble in horse kidney, while it is partly soluble and partly insoluble in hog kidney. Although extracts of tissue may not contain all of any particular enzyme present in the intact tissue or a homogenate, the possi-

bility of increased activity after solubilization must also be borne in mind, as pointed out by Mathies (1951). This worker advanced evidence to show that a fatty substance may be responsible for the difficulty of extracting alkaline phosphates from swine kidney in contrast to ready extraction by the Albers and Albers procedure from sheep and horse kidneys. Edlbacher and Kutscher's (1932) observation of an inhibitor to nucleotidase in liver, removable by acetone, is of interest in this connection. A special difficulty in apyrase estimation was stressed by Swanson (1951) who obtained some evidence that more than one apyrase is present in liver (of rat), possibly activated differently by Ca^{++} and Mg^{++}; thus it would be necessary to perform separate assays in the presence of each of these ions at optimum concentrations to gain a picture of the total apyrase activity in tissues. According to Swanson as much as 60-70 per cent of the apyrase activity in liver is ignored when the value obtained with Ca^{++} as activator is taken. In the present study no activating ions were added, since the problem was confined to a comparison of the extent of ATP breakdown by various liver extracts in their original state. A final variant affecting enzyme concentrations has come to light in the observations of Richert and Westerfield (1950) that liver xanthine oxidase activity can be abolished by a special low protein diet. Rapoport (1945) reported that the distribution of nucleotides in rat livers depends on the nutritive state of the animals. Although this may be connected with the nucleotide requirements for carbohydrate metabolism, a more direct effect on enzyme concentrations cannot be excluded offhand. Thus it is becoming increasingly clear that a large number of factors has to be taken into account for any comparative study of enzymes or enzyme systems in different tissues and different animals.

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Some New Cirripedes from the Madras Coast

BY

A. Daniel
Zoological Research Laboratory, Madras University

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ABSTRACT

Four new cirripedes from the coast of Madras, three belonging to the genus *Lepas* and one to the genus *Octolasmis* are described in detail. Of these, the *Lepas* spp: are new geographical subspecies, while *Octolasmis clubii* is a new species.

Introduction: In the course of a detailed study of the cirripede fauna of the Madras Coast over sixty species and subspecies of cirripedes were identified and described and it was found that eleven were new to science. Of the four new forms fully described in this paper (1) *Lepas hilli indicus*, (2) *Lepas pectinata longi tergata*, (3) *Lepas pectinata dilatata* are geographical subspecies of the genus *Lepas*, while (4) *Octolasmis clubii* is a new species, the genus *Octolasmis* having been recorded from India before. In view of the interest of the problem of speciation in widely distributed groups of animals, the occurrence of this species and subspecies in Indian waters would be of special significance. All types will be deposited in the Indian Museum, Calcutta.

(1) *Lepas hillii indicus*, sub. sp. nov. (Pl. 1. Fig. 1.).

Record: — Twenty five specimens of this subspecies were obtained from a floating log off Mahabalipuram on 19th August 1952 and nine specimens from Madras on 8th November 1952.

Size: — The specimens obtained had a capitular length of 14 mm. with a breadth of 8 mm. and a peduncular length of 8 mm.

Shape: — Capitulum elongated from the base to the apex, bulging out laterally, carinal margin almost straight towards the base and strongly arched at the apex, occludent margin deeply arched with the basal margin straight.

Valves: — All the valves are smooth externally.

Scutum: — (Pl. 1. Fig. 1.) is triangular with the basal margin convex and the apex elongated into a point without any umbonal tooth and without any trace of the internal basal rim.

Tergum: — (Pl. 1. Fig. 1.) is axe shaped and is far removed from the carina.

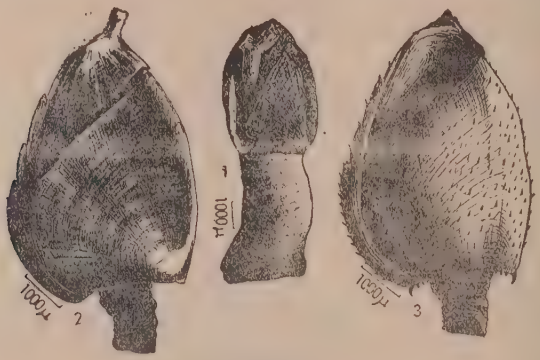

PLATE I.

Fig. 1. *Lepas hilli indicus.* sub. sp. novo. Entire animal —side view. *Fig.* 2. *Lepas pectinata longitergata.* sub. sp. novo—Entire animal—side view. *Fig.* 3. *Lepas pectinata dilatata.* sub. sp. novo—Entire animal—side view.

Carina: — (Pl. Fig. 1.) is almost straight and is separate from the other valves with the base forked which is directed upwards and inwards. The peduncle is longer than the capitulum in the specimens examined and is almost as long as the capitulum.

Cirri: — The number of the segments in the anterior and posterior rami of the Cirri in the specimens examined is as follows:

I Cirrus—11, 19; II. Cirrus—10, 12; III. Cirrus—12, 12; IV. Cirrus—14, 14; V. Cirrus—16, 16; VI. Cirrus—16, 16.

Filamentary appendages: — are three in number on either side, one in the flank of the prosoma and a pair beneath the basal articulation of the first cirrus.

The mouth parts of this subspecies are as described in detail by earlier authors for the type species.

Remarks:—This subspecies *Lepas hillii indicus* can be distinguished from the species by the axe shaped terga and the almost straight carina which are important features in the classification of this genus.

(2) *Lepas pectinata longitergata,* sub. sp. nov. (Pl. 1. Fig. 2).

Record: — Over fifty specimens of this subspecies were collected from the logs off the Madras Coast between November 1952 and February 1953.

Size: — The specimens obtained have a capitular length of 3·5 mm. with a breadth of 2·5 mm. The breadth of the peduncle is 1·5 mm.

Colour: — The valves are pale white with the peduncle dark brown.

Shape: — The capitulum is bulged out laterally more so towards the base with the apex elongated.

Valves: — As is typical for in the type of the species, the valves are very thin and brittle with the external surface strongly furrowed.

Scutum: — (Pl. 1. Fig. 2). With the basal margin being nearly straight, the occludent margin being uniformly arched and the carino-tergal margin very broadly arched with the tip elongated into a point. There is a very prominent ridge of the scutum from the umbo to the apex close to the occludent margin.

Tergum: — (Pl. 1. Fig. 2.) With the apical tip elongated and the lower margin bears a small depression which accommodates the pointed tip of the scuta.

Carina: — (Pl. 1. Fig. 2.) is finely pointed at the tip with the based of the carina forked.

The peduncle is 1/3 as long as the capitulum. The number of the segments in the anterior and posterior rami of the cirri in the specimens examined is as follows:

I. Cirrus—9, 7; II. Cirrus—8, 12; III. Cirrus—12, 12; IV. Cirrus—11, 11; V. Cirrus—11, 11; VI. Cirrus—12, 12.

As is the case for the typical form of this species the pedicel of all the cirri are rather very long. A very small and inconspicuous filamentary appendage is present at the base of the 1st cirrus.

Anal appendage—absent.

Mandible—6 toothed, with upper margin of the 2nd to 6th teeth bearing pectinated spines as in the case of the typical form of this species.

Remarks: Lepas pectinata longitergata sub sp. nov. differs from the typical form of this species, and from the variety described by Darwin 1851, and the variety *squamosa* (Fischer, 1884) and the subspecies *beringiana* (Pilsbry, 1911) and the subspecies *pacifica*

(Henry, 1942) and the new subspecies *dilatata* herein described, by the presence of the elongated apex of the terga. It differs from all except the subspecies *pacifica* by the absence of the caudal appendage and the absence of the internal umbonal teeth in the scuta. It differs from the subspecies *pacifica* by the double occludent margin of the tergum and from the subspecies *dilatata* in the absence of a caudal appendage.

(3) *Lepas pectinata dilatata* sub. sp. nov. (Pl. 1. Fig. 3.).

Record: — Ten specimens of this subspecies were collected from algae washed ashore in the Krusadi islands during November 1951.

Size: — The specimens obtained have a capitular length of 2·5 mm., with a breadth of 1·5 mm.

Valves: — As is typical for this species the valves are very thin and brittle and very strongly furrowed as is the case of the new subspecies *longitergata,* and in addition a number of spines are present on the external surface.

Scutum: — As in *Lepas pectinata longitergata,* with the base being slightly concave. The external surface is more deeply furrowed than in the previous subspecies. The basal margin of the scuta bear a small row of teeth with a pair of larger teeth at the basal tip of the occludent margin, (Pl. 1. Fig. 3.) as is described for the variety *Lepas anserifera var. dilatata.* There are a number of very small teeth on the external surface on the occludent half of the scuta. (Pl. 1. Fig. 3). There are no umbonal teeth.

Tergum: — Has a small depression at the lower margin which accommodates the pointed apical tip of the scuta as in the typical form of this species.

Carina: — Is barbed and is provided with a number of small teeth on the surface with a pair of large downwardly directed teeth (as in Pl. 1. Fig. 3). The peduncle is 1/3 as long as the capitulum. In this subspecies also the pedicel of all the cirri are very long. A single filamentary appendage is present at the base of the first cirrus. A small claw-shaped caudal appendage is present.

Remarks: — *Lepas pectinata dilatata* sub. sp. nov., differs from the typical form of this species, and from the variety described by Darwin 1851, and the variety *squamosa* (Fischer 1894) and the subspecies *beringiana* (Pilsbry, 1911) and the subspecies *longitergata* by the presence of a single occludent margin of the tergum.

It differs from all excepting the subspecies *pacifica* (Henry 1940) and the subspecies *longitergata* sub sp. nov., in the absence of internal umbonal teeth and can be distinguished from the subspecies *pacifica* and *longitergata* by the presence of a caudal appendage and it differs from all the known subspecies by the presence of teeth on the external surface.

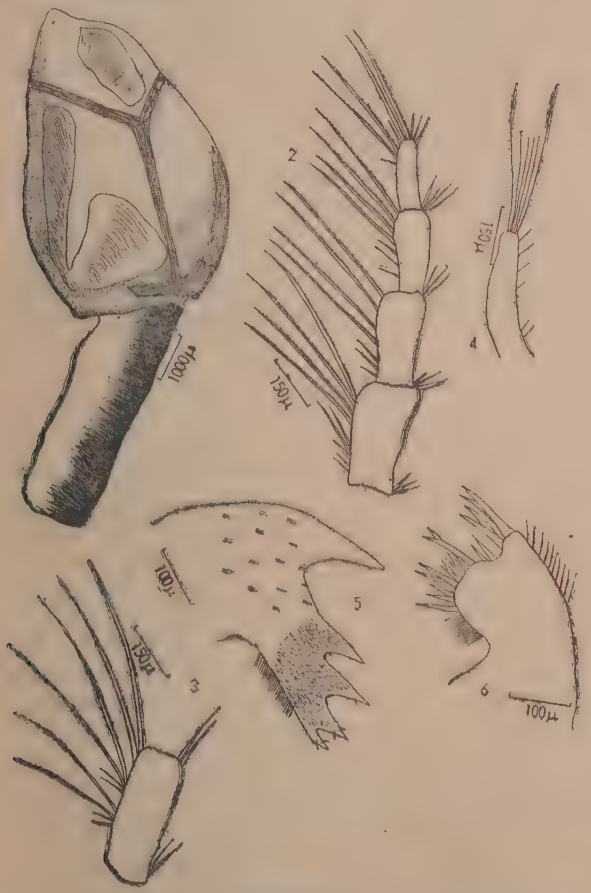

PLATE II.

Fig. 1. *Octolasmis clubii* n. sp. Entire animal—side view. *Fig.* 2. Second cirrus—terminal segments of anterior ramus. *Fig.* 3. Single segment of 6th cirri. *Fig.* 4. Caudal appendage. *Fig.* 5. Mandible. *Fig.* 6. Maxilla I.

(4) *Octolasmis clubii* sp. nov. (Pl. II. Fig. 1-6).

Record: — Ten specimens of this species were obtained from a crab *Neptunus sanguinolentus* on 26th June, 1952.

Size: — The specimens obtained had a capitular length of 8 mm. with a breadth of 5 mm. and a peduncular length of 6 mm.

Shape: — (Pl. II. Fig. 1). Capitulum ovid, not much laterally flattened, carinal margin strongly arched, occludent margin sinuous and irregular, with the lower margin almost straight.

Valves—Scutum: (Fig. 1). Calcified into two segments; occludent segment linear and slightly arched with the apex being broad and with a constriction near the base; carinal segment being very broad and triangular.

Tergum: — (Pl. II. Fig. 1) is club-shaped with the apex being bluntly pointed, the basal margin of the tergum reaching the apical tip of the occludent segment of the scutum.

Carina: — (Pl. II. Fig. 1.) with the apical tip narrowly pointed and well below the apical tip of the occludent segment of the scutum, with a transverse fissure near the base which is strongly forked.

Peduncle: — is almost as long as the capitulum.

Cirri: — The number of the segments in the anterior and posterior rami of the cirri in the specimens examined is as follows:

I. Cirrus—6, 6; II. Cirrus—10, 19; III. Cirrus—10, 10;

IV. Cirrus—12, 12; V. Cirrus—12, 12; VI. Cirrus—12, 12.

In the first cirrus the basal segments are very long, the anterior margin of both rami bearing a dense fringe of hairs. In the second and third cirri each segment is provided with two pairs of long spines and two pairs of small spines. The long spines of some of the distal segments of the anterior ramus are serrated on one side only (Pl. II. Fig. 2). The 4th, 5th and 6th pairs of cirri are alike in shape and structure. Each segment bears 3 pairs of long spines with intermediate small pairs of spines. (Pl. II. Fig. 3).

Anal appendage: — (Pl. II. Fig. 4.) is elongated and it bears at its distal tip two very long spines with 4 short spines in between, and are followed by 6 very short spines on their inner margin.

Mouth Parts: — *Labrum:* is bullate and provided with teeth. *Mandible* (Pl. II. Fig. 5.) has 5 teeth, the first tooth is far removed from the other teeth, the third tooth is provided with a small spine at its lower margin, the 4th and 5th teeth bearing two such small spines on either side as in the figure. *Maxilla* I (Pl. II. Fig. 6)—the cutting edge which has an incissure bears a pair of long and a pair

of shorter spines above it, with a very short pair of spines in the depression. The free edge of the lower half bears two pairs of long spines and two pairs of short spines followed by 3 short spines. The upper and the lower margins are fringed with fine hairs as in figure. *Maxilla* II is broad and rounded.

Remarks: — The genus *Octolasmis* is represented in the Indian Ocean region by the following 13 valid species: *O. angulata, O. bathynomi, O. cor, O. lowei, O. rhinoceros, O. sessilis, O. sociabilis, O. stella, O. warwickii, O. nierstraszi, O. orthrogonia, O. tridens,* and *O. grayii.* The present form closely resembles *O. warwickii,* (Gray) 1825, and *O. nierstraszi* (Hoek) 1907, in the shape of the scutum and the transverse fissure on the carina but it differs from them in the terga being club-shaped, the tip of the carina being well below the apical tip of the occludent segment of the scutum, in the long spines of the distal segment of the anterior rami of the 2nd and 3rd pairs of cirri being pectinated on one side, in the 4th and 5th teeth of the mandible bearing two short spines on either side. Hence this is treated as a species new to science and can be defined as follows:

Capitulum ovid, 8 mm. in length and 5 mm. in breadth; tergum club-shaped; carina with its apical tip well below the apex of the occludent segment of the scutum, the long spines of some of the distal segments of the anterior ramus being serrated on one side only. Mandible 5 toothed, with the fourth and fifth teeth bearing two well developed spines; the free edge of the maxilla bearing an incissure with two pairs of spines above it with a very short pair in the depression.

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The Attachment of Barnacle Cyprids to Different Types of South Indian Timber

BY

A. DANIEL

Zoological Research Laboratory, Madras University

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ABSTRACT

The results of a series of experiments conducted in the Madras harbour on the rate of attachment of barnacle cyprids to the following different types of South Indian timbers, (a) Teak—*Tectona grandis*, (b) Venteak—*Gmelina arborea*, (c) Deal wood—*Myristica fragrans*, (d) Margosa (Neem)—*Azadirachta indica*, (e) Portia wood—*Thespesia populnea*, (f) Marudu—*Terminalia arjuna*, (g) Mango—*Mangifera indica* are described. It was found that the number of barnacle cyprids that had settled on Margosa—*Azadirachta indica* was comparatively lower than the number settling on teak. It was also found that on an average about 220 barnacle cyprids were attached to 160 sq. in of the margosa (or Neem) timber in a month; about 440 barnacle cyprids to teak, and from 600 to 1250 barnacle cyprids to the rest of the timbers. The probable reasons for the differential rate of attachment are discussed.

INTRODUCTION

That timber used in the sea or brackish water is damaged considerably by wood boring animals as well as by barnacles and other sessile animals which attach on the surface is well-known. While the boring forms eat into the wood, make it soft and destroy it, the barnacles form such a thick coating that the outer layer of the wood peals off, thus weakening the timber. Although considerable work has been done on this problem in the temperate waters, the destructive action of the foulers, more marked in the tropical areas has received but scant attention. Excepting for a preliminary survey of marine boring organisms in Cochin harbour (Erlanson, 1936) and a note on the attachment of marine sedentary organisms (Kuriyan, 1952) very little is known about the resistance capacity of the Indian timbers and the extent of damage caused by the different organisms settling on them. Since this is of major importance in harbour constructions and the durability of country

TABLE

Month	Period of Submergence in days	*Types of Timber*						
		Teak	Venteak	Deal	Margosa	Portia	Marudu	Mango
1952								
October ..	3	—	—	5	—	—	—	—
	14	86	148	418	4	516	618	596
	30	268	386	996	18	816	912	818
November ..	3	—	—	—	—	—	—	—
	14	286	486	496	26	386	246	416
	30	614	916	1018	112	694	596	814
December ..	3	—	—	—	—	—	—	—
	14	116	112	286	48	218	396	286
	30	218	286	646	98	396	548	619
1953	3	—	—	—	—	—	—	—
January ..	14	312	416	310	116	416	846	462
	30	614	810	1684	596	816	1706	1008
February ..	3	—	—	—	—	—	—	—
	14	126	286	486	146	596	819	916
	30	618	846	1896	910	1346	1560	1680
March ..	3	—	5	8	—	—	18	21
	14	126	318	618	18	686	816	904
	30	368	518	1888	112	916	1198	1684

April	..	3	—	—	—	—	—	—	—
		14	218	286	346	392	496	614	716
		30	396	416	818	512	712	948	912
May	..	3	—	—	—	—	—	—	—
		14	192	218	310	214	280	314	418
		30	680	690	760	412	516	418	618
June	..	3	—	—	—	—	—	—	—
		14	196	262	246	240	310	416	590
		30	342	418	818	310	480	812	892
July	..	3	—	—	—	—	—	—	—
		14	118	312	618	18	290	460	492
		30	346	462	896	92	590	680	648
August	..	3	—	—	—	—	—	—	—
		14	114	516	890	90	910	274	496
		30	310	1102	1800	190	1190	540	612
September	..	3	—	—	—	—	—	—	—
		14	296	316	290	18	612	718	1406
		30	560	416	1810	90	1200	906	1900

crafts it was felt that a study of the rate of attachment of barnacle cyprids, the most important surface settlers, on the different kinds of South Indian timber would be useful. Teak (*Tectona grandis*), Venteak (*Gmelina arborea*), Deal wood (*Myristica fragrans*) Margosa (*Azadirachta indica*) Portia wood (*Thespesia populnea*), Marudu (*Terminalia arjuna*) and Mango (*Mangifera indica*) were the type of South Indian timber chosen for the study of resistivity to the attack of these foulers.

Experiment and Results

Test panels of these timbers measuring $8'' \times 10'' \times 1''$ were immersed below the lowtide mark at the New North Quay in the Madras harbour (as described in detail. Daniel, 1953). The number of cyprids that settled on both the sides of a total area of 160 sq. in. were counted omitting those that had settled on the edges. Such counts were made on ten days in each month with three days intervals between each count. On the first of the next month the panels were scraped clean and set once again for the next months' readings. The approximate numbers of barnacle larvae that had settled on the different test panels are tabulated (pages 228-229) as totals of count at the end of three, fourteen and thirty days in each of the twelve months of study.

REMARKS

A perusal of the Table will show that margosa *Azadirachta indica*) test plank is most unfavourable for the settlement of the barnacle larvae while deal wood (*Myristica fragrans*) and mango wood (*Mangifera indica*) are most favourable for the settlement. The difference between these types of timber may be due to the presence in margosa and teak of a large amount of alkoloids and resinous substances which are leachable in sea water. It may also be due to the fact that both margosa and teak have a close grained texture which may render the surface less rough than those of other timbers. If detailed studies on the detrigent substances in the different timbers as well as the difference in the texture of the wood are made, further light may be thrown on this subject.

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Carbohydrate and Fat Contents of Fishes

BY

T. S. RAMASWAMY

Zoological Research Laboratory, University of Madras

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ABSTRACT

Only a trace of carbohydrate was found in *Saurida tumbil and Otolithus ruber*. This is supported by the findings of Stirling (1884), Milroy (1908), Greene (1921) and Bruce (1924). The absence of large reserves of carbohydrates may be due to the fact that the copepods and other invertebrates on which the fishes feed do not have appreciable amounts of carbohydrates. This again is obviously because the diatoms on which these invertebrates feed never have a storage of starch (Smith 1950). The small quantities of glycogen detectable in copepods and other invertebrates are sufficient for their tissue metabolism and so there are no large reserves to be passed on to the fish. Consequent on the absence of carbohydrate reserve all the fat the fish contains must be derived from the food as fat.

One of the reserve food materials in man and many higher vertebrates is carbohydrates derived largely from food consumed. In the average man approximately 100 gms. of glycogen are present in the liver. In addition, the COOH acid group of the glycoproteins of food viz alanine, arginine, aspartic, cystine, glycine, glutamic, hydroxy-glutamic, proline and serine, may be transformed into glucose and this sugar is also available for fat synthesis. The quantity of these amino-acids present in 100 gms. of protein is sufficient to form some 58 gms. of glucose. (Best and Taylor, 1950). The nucleic acid also forms a source of carbohydrate and on hydrolysis yield four molecules of a pentose ($C_5H_{10}O_5$) and in addition the mononucleotides viz. adenosine-triphosphate, hypoxanthylic and guanylic acids, each can give rise to a sugar d-ribose. It is also known that in muscular exercise lactic acid produced, in the anaerobic phase of muscular contraction, diffuses into the blood stream to be converted into glycogen (The Cori-cycle). Glycogen containing tissues, with the exception of the liver where it is con-

verted into glucose, exhibit the same pattern of breakdown of the polysaccharide. The transformation of carbohydrate to fat in animals is well known and it was expected that the formation of carbohydrate also would take place by a reversal of this process. Although, the change of fat to carbohydrate in the plant kingdom has been well established, direct evidence for this conversion is not available in animals (Best and Taylor, 1950) as has been shown in the reviews by Soskin (1941) who summarizes evidence in favour and by Stadie (1940) who believes this change does not take place in animals.

Milroy (1908) working on the changes in the chemical composition of the herring during the reproductive period, thought that glycogen might show regular alteration in its amount as did the fat of the muscle tissue. Although unable to carry out series of glycogen determinations, he found that the amount of glycogen in the spent fish was extremely small. That carbohydrates are practically absent even in well fed fishes was the opinion of Johnstone (1915). Similarly Greene (1921) working on the carbohydrate content of the king salmon tissues during the fast of spawning migration found no glycogen in the skin, stomach and testes while a trace of glycogen was detected in the muscle tissue in the early part of the journey, although a very small quantity of glycogen was found in the liver and gonad throughout the journey. However Milroy had analysed the tissues of the herring for glycogen at a time when it was not feeding. Greene estimated the glycogen found in the salmon during the migrating period when the fish starves. It is known that during starvation the glycogen store is first depleted, then fat and finally the proteins (Best and Taylor, 1950). Bruce (1924) working on the changes in the chemical composition of the tissues of the herring in relation to age and maturity did not find any glycogen or glucose in his tests with the liver of the herring. He also felt that the amount of carbohydrate as glycogen or in any other form in the tissues of the herring and in fact most of the marine fishes appeared to be negligible throughout the year. Besides Stirling (1884) was able to demonstrate but the merest trace of reducing sugars in the livers of filling herrings and showed that this condition was independent of food intake.

If glycogen is present and if it is converted into fat in the body of an animal, such an income of fat must be taken into all calculations of fat income, expenditure and storage. The amount of fat so synthesised must be added to the fat income from food taken

by the fish. Only a trace of glycogen was detected in the present work and it was concluded that all the fat in the fish must have been obtained from natural sources viz. food. The failure of other authors to find an appreciable amount of glycogen in the tissues of fish appeared to call for an explanation. Either the food consumed must be equally poor in carbohydrate or all the carbohydrate is used in metabolism.

It is obvious, *a priori,* that all the animals in the sea must derive their food from the photosynthesis of diatoms which form nine-tenths of the plankton in general (MacGinite, 1949). An idea of the abundance of the diatoms in the sea (the producing group) which form the food of the copepods (the animal consumers) could be had from the works of Johnstone (1908), Lohman (1911), Hjort (1912), Gran (1912, 1930), Lebour (1921, 1922, 1923), Herdman (1923) and others. The copepods are in turn eaten by the fishes directly (Bullen 1908, 1912; Lebour 1918, 1919, 1921; Hardy 1924, 1925; Jespersen 1928; Campbell 1934; Clarke 1934; Foerester 1933; Marshall 1939) or indirectly thus forming a food cycle of the diatoms, copepods and fishes, in the main. However, the diatoms are the ultimate producer in the food cycle being capable of photosynthesis. Food reserves include both fats and an insoluble reserve (volutin) but there is never a storage of starch (Smith 1950). While, Meyer (1904) maintained that the volutin grain was constituted of nucleic acid, Beauverie (1908) found in the globoids certain nitrogenous substances allied to volutin, utilizable as embryonic reserve (Guilliermond, 1910) of the nature of organo-mineral material. (saccharo-or glycerophosphates of Ca and Mg.) as revealed by chemical analysis of Pfeffer (1872). Guilliermond and Mawas (1908) observed a close correspondence between the basophil granulation of leucocytes and volutin and concluded that these granulations possibly formed the volutin grains in others. Thus it is to be noted that in the sea the diatoms that form ultimately the food of all marine organisms do not store food as starch but as fats chiefly (Smith 1950), although it is well-known that reserve food in higher plants is stored as carbohydrates as well as fats. Hence the copepods that feed largely on these diatoms (Dakin 1908; Esterley 1916; Lebour 1922, 1923; Harvey 1928; Marshall 1924, 1924; Campbell 1934; Clarke 1934; Wimpenny 1936) do not draw any large amount of starch from these algae and possibly the fish and other invertebrates feeding directly or indirectly on these diatoms and copepods are unable to store any significant amount of carbohydrates for storage. Hence the fishes in general

do not obtain sufficient amounts of glycogen to be stored for utilization and for conversion into fat, when in excess. However, it has been shown that the income of carbohydrate through food for the fish itself is too small, the possibility of this glycogen being converted into fat is not likely to be great. Probably in fishes the very small quantities of glycogen detectable are sufficient for their tissue metabolism and hence large quantities of glycogen are not stored. Hence the food material comes in only as fat and protein which go to build up the body. Finding that vitamin A is not a *sine quo non* for assimilation of either protein or fat, Edisbury *et al* (1938) were of the opinion that in most of the larger carnivorous fish the mechanism of food assimilation will be primarily concerned with the metabolism of protein and fat rather than carbohydrate. Lovern (1932) in a general survey of the fatty acid composition of the fats of a number of fishes both marine and fresh water, showed that the composition of the carnivorous fishes will be decided largely by the type of fat in their food, since their carbohydrate intake is low and fat synthesis from this source is not likely to be great. He further states that as protein can be converted into carbohydrate there is a possibility of fat being formed from protein, but the process seems an extravagant and a wasteful one and concluded that "The writer is unaware of any evidence in support of this hypothesis", showing thereby that the income of fat in fishes is solely as fat from food. He arrived at the same conclusion later (Lovern 1934) while working on the salmon in which he found that the egg fat always had a higher iodine value than the liver fat in every case he had examined. He showed that this higher unsaturation of egg fat was due to a selective mobilisation of depot fat which had been passed on to the ova, and the remainder being consumed as fuel. Giving an alternative explanation of the observed results and assuming that ova fat has not been derived from the depots, but has been specially synthesised by the fish from carbohydrates or protein sources, he puts forth a number of facts against such a possibility. He showed that the carbohydrate reserves of the fish are not large and if catabolism for energy requirements is analogous in the salmon to that of mammals, this carbohydrate must be largely consumed along with fat or ketosis would set in, although now the saying that "The fats burn in the fire of carbohydrate" is no longer tenable (Best and Taylor 1950). Also he maintained that the production of fat from protein would be such a wasteful process that it is almost unthinkable in the case of a starving animal especially in view

of the large quantities of special proteins deposited in the developing gonads. Lastly, in the case of mammals there is sufficient evidence to show that the fat synthesised from carbohydrate is of a relatively simple type, and it may be the same applies to fishes also in general. Hence in treating the fats under two headings viz. fat income and fat distribution we need not take any cognizance of the conversion of fat from carbohydrate, as we have to do in the case of higher animals.

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Food of the Indian Herrings *

BY

P. VIJAYARAGHAVAN
Zoological Research Laboratory, Madras University

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ABSTRACT

From analyses of the stomach contents of 358 specimens of *Pellona elongata* (Benn.), 337 of *P. indica* (Swains), 665 of *P. hoevenii* (Blkr.) and 6 of *P. brachysoma* (Blkr.), it was found that while teleosteans and crustaceans form the two major food items of these fishes, the former appears to be the favourite food of *P. elongata* and the latter the chief food of *P. indica, P. hoevenii,* and *P. brachysoma.*

It was also found that when more crustaceans were consumed, only a small volume of teleosteans formed the food and *vice versa,* But the consumption of both these items may be simultaneously reduced or increased, correlated with the increase or decrease in the general feeding activity.

These Indian herrings which are landed during certain months of the year from the inshore waters, become scarce during the rest of the year. While it is probable that they migrate into the inshore waters of Madras when these crustacea and young teleosts, they feed on, abound in the area, it is difficult to explain why they leave the inshore waters during other months since their food organisms continue to occur in the environment.

Though the true herrings belonging to genus *Clupea* do not occur in the tropical belt, they are represented in the Indian waters by genus *Pellona* of which four species (*Pellona elongata, p. indica, P. hoevenii* and *P. brachysoma*) occur in the Madras coast and are usually known as the Indian herrings. The Indian herrings have not been subjected to any scientific study and information concerning their food and feeding habits is meagre. Devanesan and Chidambaram (1948) and Chacko (1949) have made a few passing remarks on the subject. In the present paper a brief report of the

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food of *P. elongata P. indica, P. hoeveni* and *P. brachysoma* based on the analyses of the stomach contents of adult specimens collected during the course of two years from the inshore catches, from the Chepauk, Triplicane and San Thome areas of Madras coast, is presented. The same methods as those described by the author elsewhere (1951) were followed in the analysis of the stomach contents.

Family — Clupeidae
Subfamily — Clupeinae
Genus — Pellona
Species — *Pellona elongata* (*Benn.*)
Pellona indica (Swains)
Pellona hoevenii (Blkr.)
Pellona brachysoma (Blkr.)
Pellona elongata (Bennett)
Tamil name, 'Poovali'.

Though not very common right through the year, they constituted a good proportion of the landings during October, November and December and a few were caught in June and July. Stomach contents of 358 specimens were examined and their lengths ranged

TABLE I

Volume percentages of the food components of *Pellona elongata*

Months	July	Oct.	Nov.	Dec.	June
Teleosteans ..	13·77	22·89	10·40	18·80	8·00
Crustaceans ..	22·22	1·79	0·56	11·00	8·00
Acetes ..	22·22	1·79	0·56	11·00	8·00
Mysidaceae ..	0·44	0·47	—	—	—
Lucifer ..	0·78	—	0·78	0·60	—
Penaeus ..	—	—	0·11	—	—
Decapod larvae ..	0·22	1·69	3·39	2·20	—
Paguridae ..	0·78	0·85	—	—	—
Copepoda ..	—	0·06	—	—	—
Ostracoda ..	0·16	0·42	2·00	—	—
Squilla	—	1·06	2·00	1·60	—
Crustacean remains ..	—	0·32	1·56	3·40	—
Molluscan larvae ..	0·39	0·46	0·39	0·80	0·25
Polychaeta ..	0·44	0·63	—	0·80	0·20
Algae ..	—	0·11	1·11	—	—

between 9·6″ and 12·4″. Analysis of the stomach contents showed that 18 out of 25 specimens examined in July, 119 out of 122 in October, 118 out of 120 in November, and all the 90 examined in December contained food. Only a single specimen was obtained in the month of June and its stomach was full.

It will be seen from Table I, that the fish is a predaceous carnivore deriving its food mainly from young and post larval teleosteans, species of *Engraulis* and *Caranx* being the usual victims. Crustaceans, especially species of *Acetes* form the important item of the food of the fish, while sergestids, penaeids, larval decapods, stomatopods and entomostracans are the other crustaceans preyed upon. Occasionally molluscan larvae and polychaetes occurred in the stomach contents, and rarely small amounts of algae and diatoms were detected.

Pellona indica (Swains)
Tamil name 'Therakuthuvai'

Moses (1922) has reported the occurrence of this species as rare in Madras. But during the present investigation it was observed that the fish was landed in appreciable numbers between July and January. A total of 377 fish whose size varied between 5·8″ and 7·7″ were analysed. Analysis of the stomach contents showed that 16 out of 22 specimens examined in July, all the 23 specimens in August, 18 out of 19 in September, 26 and 75 respectively in October and November, 116 out of 120 in December and 84 out of 92 in January contained food.

On studying the food contents (Table II) it was observed that as crustaceans formed the predominant item of its menu, small teleosteans mostly clupeids and young prawns (*Penaeus indicus*) were the favourite food of this Species Copepods (*Pontellopsis* sp. and Oithona spp.) ostracods, *Acetes erythraeus*, Lucifer sp. and pagurids and larval stomatopods were the crustaceans that were commonly met with in the stomach contents. Molluscan larvae and polychaetes were the other minor items of diet. Although a few diatoms and algal filaments were identified in the stomach contents, the amount of these vegetable items being very negligible, the fish may be considered purely carnivorous.

Pellona hoevenii (Bleeker)
Tamil name, 'Kuthuvai'.

Pellona hoevenii is the commonest of all Indian herrings caught in Madras and is available almost throughout the year. During

TABLE II

Volume percentages of the food components of *Pellona indica*

Months	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
Teleosteans	18000	—	13·44	4·16	—	2·06	1·43
Crustaceans	18·51	8·19	45·19	53·82	30·00	33·04	48·15
Acetes	5·50	—	—	—	—	—	8·29
Lucifer	—	—	—	—	—	0·13	1·29
Mysidaceae	0·75	—	12·50	40·00	—	—	—
Penaeus	0·69	0·31	5·13	9·10	—	12·19	—
Paguridae	2·13	—	3·75	—	—	—	—
Decapod larvae	—	—	6·56	2·00	3·00	1·28	27·14
Copepoda	2·31	0·38	0·81	1·16	25·00	1·19	6·14
Ostracoda	0·19	—	0·75	—	—	0·25	0·43
Squilla	3·38	—	1·50	—	—	—	3·00
Crustacean remains	3·56	7·50	14·19	1·66	2·00	18·00	1·79
Molluscan larvae	0·13	—	0·25	0·16	0·60	0·19	0·35
Pycnogonida	0·19	—	—	—	—	—	—
Polychaeta	—	—	5·00	—	—	—	—
Algae	—	—	—	—	—	0·38	—

the present investigation it was found that from August till the end of February the catches were rich in this species. Stomach contents of 665 specimens varying between 7·6" and 6·1" in length were analysed. 8 out of 12 specimens examined in July, all the 85 examined in August, 73 out of 75 in September, 92 out of 97 in October, 128 out of 132 in November, 80 out of 84 in December, 72 out of 80 in January all the 82 in February, 18 out of 20 in April and all the 8 specimens examined in June had food in their stomach.

As indicated in Table III, crustaceans formed the bulk of the fishes' menu. *Acetes erythraeus* and *Penaeus indicus* were the commonest crustaceans met with in the stomach contents. Copepods (*Oithona* spp., *Corycaeus* spp., *Acartia* sp., *Pontella* sp., *Pseudodiaptomus* sp. and *Macrosetella* sp.) ostracods, amphipods, (*Gammarus* spp.), larval stages of *Squilla* spp. brachyuran larvae, *Lucifer* sp. and mysids like *Mesopodopsis* spp. formed the rest of the crustacean menu. The amount of teleosteans consumed was worthy of note and the young and post larval stages of clupeids, sciaenids, and carangids were the commonest. Occasionally larval mollusca, polychaetes and pycnogonids occurred in the stomach contents in small amounts. The presence of a few algal filaments is considered to be accidental. This fish by its piscivorous habits proves definitely harmful to the multiplication of other market fishes like *Caranx* spp., *Sardinella* spp., *Stolepherus* spp., and *Engraulis* spp.

Pellona brachysoma (Bleeker)
Tamil name, 'Vengan'.

As stated by Moses, the fish occurred only in the months of September and October and only 64 specimens were examined. Their lengths varied between 7·8" and 11·4". Analysis of the stomach contents showed that 15 out of 18 specimens examined in September and 37 out of 46 examined in October had food in the stomach.

From the analysis of the stomach contents (Table IV) the fish appears to be a predaceous carnivore. They preyed very often on non-planktonic animals like adult teleosteans and prawns. Crustaceans formed the major portion of its diet of which *Penaeus* spp. was the favourite prey. Other crustacean items which were frequently met with in the stomach contents were ostracods, copepods (*Pontella* spp., *Macrosetella* sp., *Oithona* sp. and *Euterpina* sp.), *Lucifer* spp., pagurids, and mysids (*Mesopodosis* spp.). Young as

TABLE III

Volume percentages of the food components of *Pellona hoevenii*

Months	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Apr.	Jun.
Teleosteans ..	2·50	4·00	0·87	10·18	13·82	6·70	4·55	29·17	—	—
Crustaceans ..	25·26	34·00	42·56	28·45	30·36	28·10	28·22	17·91	49·01	14·75
Acetes ..	3·13	7·56	2·39	—	—	—	8·36	—	—	—
Penaeus ..	—	10·52	8·69	7·05	1·46	8·35	2·73	2·75	22·13	—
Mysidaceae ..	—	—	—	—	0·04	—	—	—	0·38	0·25
Decapod larvae ..	11·38	4·88	2·39	1·59	7·43	1·85	3·00	5·00	0·38	0·25
Lucifer ..	—	0·36	1·22	1·00	0·21	1·10	—	—	0·25	—
Copepoda ..	1·75	4·68	14·39	0·09	5·29	1·40	1·64	3·75	3·00	1·50
Ostracoda ..	—	—	—	0·14	0·39	0·80	1·50	0·33	3·75	3·25
Amphipoda ..	—	—	0·35	0·27	0·21	0·50	2·76	0·08	—	—
Squilla ..	—	0·04	0·34	3·99	4·39	0·20	1·18	—	4·75	—
Other minor crustacean items ..	0·75	—	—	—	1·86	—	—	—	—	—
Crustacean remains ..	8·25	5·96	12·79	14·32	9·04	13·90	7·05	6·00	14·75	9·75
Molluscan larvae ..	1·50	0·36	0·30	0·69	0·43	0·60	0·41	1·34	0·13	—
Pycnogonida ..	—	—	—	—	0·04	—	—	0·08	—	—
Polychaeta ..	—	—	—	2·59	—	0·20	—	—	—	—
Eggs ..	—	—	0·09	0 14	0·17	1·60	0·41	0·25	1·00	—
Vegetable matter ..	—	0·24	0·47	—	—	—	0·05	—	0·50	5·75
Sand particles ..	—	—	—	0·05	—	—	—	—	0·13	—

well as adult teleosteans (the silverbellies, the white bait and the carangids) were very often preyed upon. Cypris larvae, pycno-

TABLE IV

Volume percentages of the food components of *Pellona brachysoma*

Months		September	October
Teleosteans	..	1·80	11·22
Crustaceans	..	18·38	18·69
Penaeus	..	3·20	7·18
Lucifer	..	0·67	1·84
Acetes	..	2·80	0·03
Pagurids	..	0·67	2·45
Mysidaceae	..	—	0·18
Copepoda	..	0·59	0·50
Ostracoda	..	2·26	0·52
Decapod larvae	..	0·53	1·84
Amphipoda	..	—	0·24
Cirripedia	..	—	0·05
Crustacean remains	..	7·46	4·22
Molluscan larvae	..	1·06	0·74
Pycnogonida	..	0·13	—
Vegetable matter	..	—	0·08
Polychaeta	..	3·20	0·71
Sand particles	..	013	0·13

gonids, polychaetes and larval molluscs were the other minor food items. The presence of algae and diatoms in the gut contents was quite negligible.

Discussion

The analyses of the stomach contents of the four species of *Pellona* reveal that these Indian herrings are predaceous carnivores which feed from the plankton as also from the nekton, crustaceans and teleosteans being the two major food items of these fishes. However, varying proportions of these are consumed by the different species studied. Thus, while young and larval teleosteans form the chief items of food of *Pellona elongata*, crustaceans are preferred by *P. indica*, *P. hoevenii* and *P. brachysoma*.

Study of the monthly variations in the proportions of these two food components in *P. hoevenii*, which is the commonest species in Madras, shows that the increase or decrease in the amount

of crustaceans consumed from July to October as well as from January to April is compensated by a corresponding increase or decrease in the amount of teleosteans taken. But between October and December we find that the crustaceans and teleosteans were consumed in more or less equal proportions, so that any increase or decrease in the total amount of food is clearly indicative of the fluctuations in the general feeding activity of the fish during the period.

Similar rise and fall in the quantities of food and changes in the proportion of the crustacean and teleostean constituents of the food are found in the diet analyses of *P. elongata*, *P. indica* and *P. brachysoma*. It is probable that the proportions of the crustacean and teleostean items of the food are altered to suit the physiological needs of the fish, while changes in the total amount of food taken may be related to the scarcity or abundance of food in the environment.

Very little is known regarding the migratory habits of the Indian herrings. One or other of the four species of *Pellona* is landed throughout the year. But when we consider the species separately we find their occurrence in the inshore waters not explainable on the basis of any general principle. Even from the analyses of food presented above, the occurrence of *P. brachysoma* in September and October alone is not quite intelligible, for this species feeds on crustaceans and teleosts mainly. These food animals are plentiful in September and October as well as in November and December. Yet *P. brachysoma* appears to leave the area by the end of October. It is probable that they move down the coast away from Madras or migrate offshore—beyond the reach of fishermen. In either case their migration cannot be due to food. Similarly P. *elongata* appears in inshore waters during June and July and for some reason or other, not due to food, they disappear in August and September and appear again in October, November and December, and leave the area thereafter. In the same way *P. hoevenii* is landed during all the months of the year except March and May. Compared with these species the occurrence of *P. indica* from July to January—a period when crustacean and teleostean larvae abound, and its absence from February to June when these food animals are scarce, appears more easily understandable. It must be admitted that the crude methods of fishing practised by the fishermen may be responsible for their not being landed during certain months of the year. It is also possible that the brief interruptions in their occurrence in the inshore area may

be due to temporary overcrowding by certain larger predatory species of fish which might scare away these small herrings.

ACKNOWLEDGEMENT

My thanks are due to Dr. C. P. Gnanamuthu, Director, University Zoology Research Laboratory, Madras, for his guidance.

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J. Madras Univ., B, XXIII, No. 3, pages 248-251, 1953

Commentaria Herbarii—I

"Presidency College," Madras-5

I. Taxonomic notes on *Pittosporum undulatum* Vent.

BY

R. Narayana Swamy

Department of Botany, Presidency College

(Received for publication, October, 21, 1953)

ABSTRACT

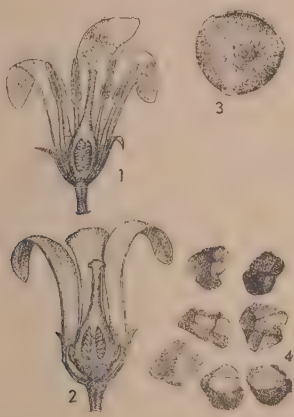
This paper contains taxonomic notes on *Pittosporum undulatum* Vent.

The Old World genus *Pittosporum* was created by Banks 165 years ago [Gaertn. Fruct. I (1788) 286, t. 59]. *Pittosporum undulatum* Vent. [Jard. Cels. (1800) pl. 76] is native to Australia (New South Wales), but is found as a naturalized plant in South India and South West China.

While describing the species in a latest monograph of the genus in the Sino-Indian region, Mari Gowda [Jour. Arnold Arb. XXXII (1951) 321] observes that the plants are polygamo-dioecious. With particular reference to the South Indian specimens of this species he mentions that the filaments are rudimentary, and that the species as a whole presents an extreme case of floral dimorphism. Thus, some flowers bear long-filamented stamens and are potentially male. Others have short-filamented stamens and the flowers are potentially female. Gowda further observes that the anthers of the long-filamented flowers "are always fertile and their tips reach the stigma or slightly beyond it. Their ovary, however, is slender and cylindrical (rather than plump) and, most important, tends to be infertile." The short-filamented stamens do not appear to be confined to *P. undulatum* alone. In the different species where such flowers occur, considerable fluctuations are met with in regard to the morphological form and expression of the short-filamented stamens. *P. undulatum*, according to Gowda, represents "An ultimate

stage of reduction", in extreme cases of which the reduced stamens may assume the form of glandular structures. The gynoecium in such short-stamened flowers is said to become "correspondingly more and more plump and fertile, and the flower as a whole more and more distinctly female."

In fresh, living material of *P. undulatum* collected from Kodaikanal (South India), certain interesting features were seen. The tree from which the specimens were secured bore flowers with



Figs. 1-4. Pittosporum undulatum. Fig. 1. Longisection of flower at anthesis, from *Fyson 2292. Fig. 2.* Longisection of flower at anthseis, from a specimen collected by the author from Kodaikanal. *Fig. 3.* Pollen grain from specimens mentioned in *Fig. 2. Fig. 4.* Mature seeds, from *Fyson 4016. Figs.* 1 and 2 are nat. si. *Fig.* 3 x ca. 300, *Fig.* 4 x ca. 5.

rather short-filamented stamens (Fig. 2), as well as fruits in all stages of development. This situation raised the question as to how fruits were produced in a tree that bears flowers with only short-filamented stamens, which, according to the published descriptions, should be sterile.

It was also observed that the fruits of this plant developed normal, embryonate seeds, which phenomenon rules out the possibility of a parthenocarpic development having taken place. The surmise that this tree may be subjected to cross pollination is also untenable as no other trees of the same species were found within reasonable distance. Therefore it was hypothesized that the flowers were *functionally* hermaphroditic in spite of their possessing

short-filamented stamens. This contention finds ample justification when the anthers of such stamens are examined for the presence of fertile pollen grains. One such pollen grain with three well developed germinal pores is represented in Fig. 3. That such pollen grains are functional cannot be doubted. Because, a comparison of the pollen grains with those from a long-filamented stamen (*Fyson 2292**, longisection of such a flower is represented in Fig. 1) reveals unmistakable identical features with regard to grain size, shape, sculpturing of the exine, structure of the germinal apparatus, etc.

Fyson 2292 shows flowers with only long-filamented stamens (Fig. 1). It could not be ascertained whether the ovary of these flowers developed to maturity as the specimens were just at the stage of anthesis. However, the development of ovules at least up to the stage of anthesis appears to be quite normal (compare ovaries and ovules in Figs. 1 and 2). This suggests that the ovaries of these flowers could continue normal post-fertilization development, thereby revealing their *functionally* hermaphroditic nature.

The flowers with short filamented stamens, as mentioned previously, produce viable seeds. The seeds measure 2-3 mm. along the longest diameter. They are irregularly polygonal in outline with unequal facets (Fig. 4, from *Fyson 4016*). The seeds collected from the living short-stamened tree bear identical characteristics.

These observations clearly indicate that although there is considerable degree of floral dimorphism in regard to external morphological and taxonomic characters, both types of flowers appear to be hermaphroditic from a *functional* standpoint. Whether these features should be embodied in a taxonomic diagnosis of the species, should receive serious consideration by the taxonomists. If they decide upon proposing a redescription or emmendation of the current diagnosis of the species, the following points justify their being included:

1. The flowers, although dimorphic *exomorphically*, may also be hermaphroditic *functionally*.

* Collector's name and field numbers mentioned in the text are those that are deposited in the Herbarium of the Presidency College, Madras. Although only the pertinent numbers are mentioned in the text, the actual number of collections examined is 10.

2. Plants bearing flowers with long-filamented stamens are as commonly found in South India as those with short-filamented stamens (Gowda mentions that the filaments occur only as rudiments in plants occurring in this region).

3. The average number of ovules per fruit is 25.
4. The seeds are irregularly polygonal with unequal facets.

ACKNOWLEDGEMENT

The author wishes to express his deep sense of gratitude to Dr. B. G. L. Swamy, Chief Professor of Botany, for his valuable help and encouragement.

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A Personality Inventory—its Reliability and Validity

BY

T. E. SHANMUGAM

Department of Psychology

University of Madras, Madras-5

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ABSTRACT

A Personality Inventory, selecting questions from Woodworth-Thurstone and Eysenck was devised in Tamil for the use of Tamil speaking population of Madras State with the idea of detecting mal-adjustment tendencies in the individuals. Since any test devised has to fulfil conditions of reliability and validity data on this Inventory was collected from samples of delinquents and adolescent boys, criminals and adolescent boys and adults. The Test-retest method of reliability, split-half reliability and 'Rational' equivalence method of reliability were used and the reliability coefficient from these three methods were found to be very high on all these methods for the different groups. When the validity of the Inventory was tested by comparing the mean symptomatic scores of the different groups—delinquent boys with adolescent boys; adult (normal) men with criminals and also delinquent boys with criminals and adolescent boys with adult men—assuming that delinquents and criminals are maladjusted individuals—no significant difference was found between delinquent and criminals. But significant differences were found between delinquent boys and adolescent boys, criminals and adults (men). It was inferred that validity of the Inventory was very high.

Introduction:

A form of Inventory measuring maladjustment tendencies in individuals is a long felt need in this part of the country. It is a well established fact that maladjustment tendencies and the consequent emotional instability not only disable an individual but it makes the job of the man—for instance a teacher in a school and a foreman in a factory who have to deal with varied and complex human individuals—who come under their care difficult. Since it is obvious that the psychologists who are available cannot possibly

interview every student or a workman nor the ready made tests standardised for other countries of different culture be used with South Indian Population in view of the cultural and language problems, a paper and pencil inventory is an important need. With this need in view, the present investigator devised an inventory, basing it mainly on Woodworth's (1920) 'Personality Data Sheet'; Thurstone and Thurstone (1930) 'A Neurotic Inventory' and Eysenck's (1948) 'Medical Questionnaire'.

Procedure adopted in selecting questions for the Inventory:

First 200 questions common for Woodworth's 'Personality Data Sheet', Thurstone's 'A Neurotic Inventory' and Eysenck's 'Medical Questionnaire' were selected and translated in Tamil. These questions were selected with a view to refer to unsocial tendencies, conflicts with home, physical symptoms, abnormal feeling reactions, phantasies, ideas of persecution, indecision and inferiority feeling. These questions were administered to 230 delinquent boys, ages ranging from 12 to 20 and 50 criminals, ages between 22 and 48. The questions were administered to delinquents and criminals, on the assumption that delinquency and crime are due to imperfect adjustments to demands of life, and these questions individually and the inventory as a whole should aid in revealing the tendencies to make faulty or inadequate adjustments. The percentage of symptomatic responses for each question, both for the delinquents and criminals were calculated and finally those questions which elicited greater* percentage of symptomatic responses were selected. However, a few questions with low* symptomatic responses were also selected on the ground that they were found to be symptomatic from the investigator's experience and from the study of abnormal psychology. Finally the inventory was formulated with 100 questions. The copies of Tamil and English versions of the Inventory can be had from the investigator.

Reliability of the Personality Inventory:

Normally a testing psychologist while devising a test and making use of it has to see whether it is highly reliable as an instru-

*The greater percentage and lesser percentage referred to values lying outside $M + \frac{2\sigma}{\sqrt{N}}$ and $M - \frac{2\sigma}{\sqrt{N}}$ respectively, where M = mean percentage of the symptomatic responses of 200 questions; σ = Standard deviation of the symptomatic responses and N = Number of cases.

ment. Technically "reliability" means, "the closeness with which two independent sets of test-measurements agree with each other". (C. Burt 1945). There are several methods which are made use of to test the reliability of a test. They are (i) the test-retest (repetition) method; (ii) the alternate or parallel forms method; (iii) The split-half method and (iv) The 'Rationale' equivalence method. All of these methods furnish 'estimates' of the reliability of the test scores. For this Inventory, the test, re-test method, split-half and the 'Rational' equivalence method were used. The alternate or parallel method was not used because, it was found difficult to form questions in Tamil language with form different, but content same and these are important factors on which alternate or parallel forms method depends. Though, these three methods used by the present investigator gave the same results, namely, the reliability co-efficient; it was felt by using all the three methods the errors of one method will be checked up by other methods, expected errors from each of these methods being different. It is felt a high reliability coefficient obtained from the three methods without significant differences between them could be taken as indicating 'high' reliability. For all these, data collected earlier on delinquents and criminals (6), adolescent boys (7) on whom the investigator used the Personality Inventory was used. Fresh data from a sample or normal adults was collected. Care was taken to see that adolescent boys and adult (normal)* men came from the same socio-economic back-ground as that of delinquent boys and (adult) criminals.

Test and Re-test method:

This method was used with adolescent boys only. In the case of delinquents and criminals re-test could not be made owing to practical difficulties too familiar to workers in the field of delinquency and crime in this part of the country—most important of them being lack of co-operation from the authorities.

The Personality Inventory was orally administered to a group of 10 boys at a time and a repeat test was administered after two weeks. The Investigator was aware of the effects of familiarity with the questions in the Inventory in the re-test, and its influence on the responses. The longer interval of two months was consi-

*The term 'normal' does not indicate complete absence of symptoms of emotional instability. The investigator is aware of the fact the 'normal' group is likely to contain a few potential or actual mal-adjusted individuals.

dered and abandoned. It was felt that even then the results may be affected owing to the fact that adolescents mature rapidly and they happened to be the subjects in this case. However, as suggested earlier, since the reliability coefficient obtained from this method was to be compared with the reliability coefficient obtained from other methods, this method was applied. In working out the reliability coefficient Pearson's Product-moment Correlation (Garrett 1949, p. 287) was used. Since the subjects were larger in number, the scattergram was adopted. The formula for the product-moment correlation is:

$$rxy = \frac{\frac{\Sigma x'y'}{N} - c'x\, c'y}{(\sigma'x)\ (\sigma'y)}$$

where $x'y'$ = denotes deviations from the guessed mean in terms of the class interval as the unit.

cx' and cy' = corrections in x and y.

$\sigma'x$ and $\sigma'y$ = standard deviations in x and y in terms of the class interval as the unit.

The Split-half method:

For the split-half method, the alternative questions (the odds and evens) were selected and constituted into two forms. The odd-even correlation was calculated by using the Pearson-Product-moment correlation and then corrected it by Spearman-Brown prophesy formula. This correction was necessary because the reliability co-efficient is found to vary with the length of the test. It is considered that a half test is not as reliable as a whole test under the same conditions. The Spearman-Brown formula for estimating reliability when a test is doubled is

$$r11 = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{1 + r_{\frac{1}{2}\frac{1}{2}}}$$

where $r11$ = self correlation of a test in its full length
$r_{\frac{1}{2}\frac{1}{2}}$ = self correlation of one-half of the test.

Reliability co-efficient based on Rational Equivalence:

In order to get around the defects of split-half method, Richardson and Kuder have suggested a new method of estimating reliability. The reasoning behind these methods emphasises the inter-

correlations among the items themselves. The formula suggested by them is as follows:

$$r11 = \frac{n}{n-1} \times \frac{\sigma^2 t - \Sigma pq}{\sigma^2 t}$$

where $r11$ = reliability coefficient of the whole test.

n = number of items in the test.
σt = standard deviation of the total scores.
p = proportion of the group passing an item.
q = proportion failing to pass the item.

Results :

Table showing reliability coefficient of Personality Inventory.

Subjects	Test-Retest			Split-Half-Test			Rational Equivalence		
	Reliability coefficient.	t-Value	Significance at 0·01 level	Reliability coefficient.	t-Value.	Significance at 0·01 level	Reliability coefficient.	t-Value.	Significance at 0·01 level
Adolescents	0·89	101·9	Yes	0·92	126·9	Yes	0·94	134·0	Yes
Delinquents	..	..	..	0·82	68·8	Yes	0·85	110·6	Yes
Adults	..	..	..	0·79	14·6	Yes	0·84	33·8	Yes
Criminals	..	..	..	0·88	40·6	Yes	0·92	52·1	Yes

The significance of the obtained r was tested by comparing the t value for obtained r with the t s' to be expected by chance at the 0·01 limits. The procedure was found to be more exact than is in terms of probable error (Garrett 1949) . The t for a given r is found from the formula

$$t = r\frac{\sqrt{N-2}}{\sqrt{1-r^2}}$$

in which r = obtained coefficient and N = the number of cases the value of t was read from table (Garrett 1949, pp. 190-191).

A study of the table will show that the reliability coefficients for the Personality Inventory on these different methods are significantly high, significant at 0·01 level of probability. It is, therefore, inferred that the reliability coefficient of the Personality Inventory is very high.

Validity of the Personality Inventory:

The term 'validity' is defined as "the closeness with which a test (or the measurement) measures the quality it was meant to measure (Burt 1945)." In order to find out the validity of the Personality Inventory the gross scores obtained from the Inventory from delinquents and criminals were compared with samples of adolescent boys and adults coming from similar socio-economic background. Then the mean gross score of individuals in each group was compared with each other—delinquents with adolescents and criminals with adolescents (normal) and also the adolescents with adults and adolescents with criminals. This was done in order to find out whether there were differences between the groups. If differences are found, particularly between delinquents and adolescents, and criminals and adults it can be inferred that the personality Inventory is a valid test of maladjustment, since by our hypothesis delinquents and criminals are maladjusted individuals.

Table showing the mean, S.D., S.E. of delinquents, Adolescent Boys, Criminals and Adults (Normal).

Subjects	No.	Mean	S.D.	S.E.
Delinquent Boys ..	230	44·8	12·52	1·77
Adolescent Boys ..	275	34·0	11·35	0·69
Criminals ..	50	44·9	17·65	1·16
Adult (Normal) ..	50	15·6	8·25	1·27

Table showing the critical ratio and its significance.

Groups	$\sqrt{\sigma D1^2 + D2^2}$	Mean difference.	Critical Ratio.	Significance 0·5	Significance 0·1
Delinquent and Adolescent Boys ..	1·90	10·82	5·69	Yes	Yes
Criminals and Adults ..	2·39	29·30	12·32	Yes	Yes
Delinquents and Criminals	2·12	0·09	0·01	No	No
Delinquents and Adults ..	2·40	29·21	12·17	Yes	Yes
Adolescent Boys and Adults	1·69	18·39	10·88	Yes	Yes

A study of the tables 3 and 4 representing mean, SD C.R. and its significance shows that there are highly significant differences between delinquents and adolescent groups and criminals and adults (normal) men, both at 0·5 and 0·1 levels of probability. This shows clearly that the Personality Inventory devised by the present investigator is a valid test of maladjustment and emotional instability in individual. Another important factor brought out by this investigation is the significant difference between adolescent boys and adult (normal) men, though difference between delinquents and (criminal adults) was low. This fact supports the general and familiar theory of adolescence as period of emotional instability. However this inference can be only tentative because for this conclusion to be valid, a sample of children also should be studied and compared with the adolescents.

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ABSTRACTS OF PAPERS PUBLISHED FROM DEPARTMENTS OF SCIENCE, UNIVERSITY OF MADRAS

Madras University: Department of Botany
Abstracts of Papers Published or in Press, 1951-53

1. **Sadasivan, T. S.:** *Role of trace elements in control of root-infecting fungi,* **Proc. Indian Acad. Sci. B. 33:** 134-149, 1951.

Some aspects of the role of trace elements in fungal growth in pure culture and in soils in the presence of plants have been reviewed. The tendency of several species of the genus *Fusarium* to accumulate inorganic salts, particularly in the presence of Zn, in a pure culture medium is discussed. The effect of soil amendments like B, Zn and Mn, on the viability and sporulation of Fusaria and consequent reduction of wilt percentage on the redgram plants has been discussed. Similarly, the effect of these three elements on the increase of bacterial populations of amended soils has been indicated and it is postulated that this increase in microbial antagonism to the Fusaria determine the longevity of the fungus in the soil and its saprophytic and parasitic phase.

2. **Ponnaiya, B. W. X.:** *Studies in the genus Sorghum: I. Field observations on Sorghum resistance to the insect pest,* Atherigona indica *M.*: **J. Madras Univ. B. 21**: 96-117. 1951.

Sorghum crop was very seriously damaged by the fly *Atherigona indica* M. at Siruguppa, Bellary District, South India when raised as the second season crop (Hingari) under irrigated conditions. A few varieties with a greater number of escapes were tested and confirmed to be resistant to the insect. The relationship of the fly to host resistance was studied.

Various ameliorative methods to enhance resistance were tried. Firstly, "time of sowing experiment" was unable to fix a 'safe date' to lessen the insect attack. Secondly, increased doses of nitrogeneous manure stimulated vigour in seedlings, but failed to enhance resistance. Thirdly, a heavier seed rate (viz., 40 lb. per acre) with a final thinning after the fourth week (seventh leaf stage) was the only successful method and resulted in uniform stand of crop.

The fly was found to lay eggs on the ventral side of the leaf blade in the youngest fully emerged leaf at a place nearer the base than the tip. No significant difference between the resistant and susceptible varieties were observed in the percentage of eggs laid in the various leaves of the plant, although the third and the fourth leaves had the maximum number of eggs. The maggot which hatched on the third day crawled to the dorsal surface of the leaf blade and entered the space between the leaf sheath and axis and reaching the base cut the growing apex.

No significant difference in the percentage of attack was found between the resistant and susceptible varieties in second and third leaf stages, but the

attack was significantly less in the fourth leaf stage of the resistant variety as compared to the identical leaf stage of the susceptible variety.

3. **Sarojini, T. S. (Miss):** *Soil Conditions and Root Diseases;* Part II Fusarium udum: *Disease of Red Gram* (Cajanus cajan (*Linn.*) *Millsp.*): **Proc. Indian Acad. Sci., B. 33:** 49-68, 1951.

1. A number of distinctly varying *Fusarium* strains were isolated during the course of the study, from wilt-sick soils (Coimbatore) and from infested host material (wilted plants from Coimbatore and the laboratory experimental plot). Comparative cultural studies with a culture of *F. udum* and the isolates revealed that the Coimbatore strains were more closely allied to the identified strain.

2. Pathogenicity tests with *F. udum* and isolates indicated that Strain I (*F. udum*) and Strains II and III were more virulent than the other strains. Pre-emergence wilt was mainly caused by Strains V and VI.

3. A greater protection to seedling emergence in wilt-infected soils was obtained by the addition of solutions of boron, manganese and zinc (especially at levels of 20, 40 and 80 p.p.m.). The beneficial effect was further seen in the increase of plant vigour, early flowering and production of better type of seeds with higher germination capacity. The pre-soaking of seeds in various concentrations of the micro-elements also induced early germination and better seedling vigour.

4. The colonization of Fusaria on host stubble was temporarily retarded by the addition of the micro-nutrient solutions, especially in the presence of zinc.

5. The survival and persistence of *F. udum* was conditioned by the presence of micro-nutrient elements in the soil, zinc being responsible for the most rapid disappearance of the fungus.

4. **Venkatram, C. S.** and **Srinivasa Pai, K. V.:** *Fertilization Value of Tank Silts:* **Proc. Indian Acad. Sci., B. 34:** 109-113, 1951.

Pot culture experimental evidence indicating the catalizing effect on paddy seedlings (as indicated by shoot length and dry weight of shoots) by addition of silt samples from tank beds has been presented. The N & K status of the silt samples has been determined and the mobilisation of these ions and the consequent increased vigour of paddy seedlings has been discussed. Addition of smaller quantities of the silt appeared to benefit plant growth to a greater extent than larger additions.

5. **Venkatram, C. S.:** *A Photographic Method for determining Apical Growth in Fungal Hyphæ.* **Proc. Indian Acad. Sci., B. 34:** 256-257, 1951.

Apical growth of *Rhizopus nodosus,* a fast growing strain isolated from cotton seed and growing on a nutritive substratum on a slide was measured at short intervals under a low powered microscopic field using the eye piece micrometer scale. The figures obtained in microns computed against time

taken between observations approximately gave colony diameter of the fungus in mm. in a short period of time.

6. **Subramanian C. V.:** *Is there a 'wild type' in the genus* Fusarium? **Proc. Nat. Inst. Sci., India, B. 17:** 403-411, 1951.

The results are presented of a study undertaken in order to elucidate the question of 'wild type' in the genus *Fusarium*.

A number of Fusaria were studied in culture immediately after their isolation from diseased or wilted plants and from soil. Amongst the isolates studied at least four taxonomic groups—Martiella, Elegans, Gibbosum and Arthrosporiella—were represented.

The Martiella and Elegans Fusaria, in particular, exhibited a very wide range of variation in regard to a number of characters like presence or absence and amount and nature of aerial mycelium, sporulation including production and abundance of microconidia and macroconidia, septation of macroconidia, and the abundance of the different septations. Between the typical sparsely sporulating mycelial form and the sporodochial or pionnotal forms with little or no aerial mycelium, there were a large number of intergrading forms. These forms have been broadly classified and are described in the text. Neither the host of choice and parasitic or saprophytic character of the fungi nor the section to which the isolates belonged had anything to do with their cultural characters exhibited in first isolations.

In first cultures, the majority of the isolates sporulated freely producing microconidia. Many of them also produced 3—or more-septate macroconidia.

It is suggested that species of *Fusarium* occur in nature in a multiplicity of forms and not as a single 'wild type' as claimed by Miller. Since sporodochia were produced by a large number of isolates immediately after isolation in first cultures, these are a natural characteristic of the genus and should be of value in taxonomic studies.

7. **Subramanian, C. V.:** *Fusaria Isolated from South Indian Soils.* **Nature, 168:** 561, 1951.

Using the root burial technique supplemented by the dilution plate technique several Fusaria were isolated from the black cotton soils of South India. Ten distinct species and five varieties were assigned to their respective positions in Wollenweber and Reinkings' key to *Fusarium* spp.

8. **Ponnaiya, B. W. X.:** *Studies in the genus Sorghum: II. The Cause of Resistance in Sorghum to the insect pest* Atherigona indica M.: **J. Madras Univ. B. 21:** 203-217, 1951.

In *Sorghum*, lignified tissue was not a factor for resistance to the insect pest *Atherigona indica*, as there was no difference in the number and size of vascular bundles and the number of cells in the fibre strands between the resistant and susceptible varieties. Two distinct kinds of Silica deposits, the dumb-bell shaped silca units occurring in regular rows and the irregularly shaped silica units lying between groups of rows of dumb-bell shaped units, bore a close relationship to the epidermal pattern.

The occurrence and position of dumb-bell shaped silica units were uniform and identical in both the resistant and susceptible varieties and this structure was, therefore, not the probable cause for resistance. The irregularly shaped silica units though absent in the second and third leaves of both the varieties, yet were well formed from the fourth leaf onwards in the resistant varieties and from the sixth leaf in the susceptible varieties. The earlier formation of these silica units in resistant varieties, therefore, indicated the basic cause of resistance to *Atherigona indica* M.

Plants grown in silica-free nutrient solution were found to have only traces of these deposits in the first three leaves, probably originating from the seeds or from contaminated air. Deposition of silica in the leaf sheath commenced only three days before emergence of the leaf but was rapid and complete on the day of emergence of the leaf. Diffused light retarded the formation of silica deposits while total absence of light not only retarded but also reduced the quantity deposited.

9. **Venkatramani, K. S.:** *An interesting instance of "Viviparous" germination in* Carica papaya *L.*: **J. Madras Univ. B. 21:** 218-219, 1951.

Viviparous germination in *Papaya* fruit has been described. These seedlings grew well when planted in soils. The lack of a dormancy period for these seeds together with the development of the green pigmentation of the cotyledonary leaves of the viviparous seeds have been discussed.

10. **Venkatram, C. S.:** *Seed-borne fungi and loss of seedling vigour in cotton.* **J. Madras Univ. B. 21:** 288-303, 1951.

The part played by seed-borne fungi in influencing germination and seedling vigour of cotton was evaluated with a view to determining the microfloral complex predisposing seed to disease incidence when germinated in soil.

1. Soaking seeds in the spore suspension and filtrate of various isolates resulted in poor germination and reduced seedling vigour, ranging from very mild forms of disease reaction to the severest manifestations of infection.

2. The mechanism of infection due to the fungal forms tested does not seem to be due to secretion of acids by the fungi.

3. Application of fungicide to the seed prior to storage is recommended to ensure better germination.

4. Sterilized soil as a medium for germination tests is advocated since the microbiological factors of unsterilized soil were found to impair germination and vigour.

5. Posssbility of controlling pathogenic activity of seed-borne fungi is suggested by proper management and modifications of soil conditions.

11. **Ramakrishnan, K.** and **Subramanian, C. V.:** *A new species of* Sirobasidium: **J. Madras Univ. B. 21:** 303-305, 1951.

S. indicum has been described as a new species occurring on dead wood. Key to the known species of the genus is given.

12. **Sulochana, C. B. (Miss):** *Soil Conditions and Root Diseases III. With special reference to colonisation and survival of Soil Fusaria in soils treated with micro-elements:* **Proc. Indian Acad. Sci. B. 35:** 209-213, 1952.

A study has been made on the effects of micro-element amendments on the saprophytic habits of Fusaria.

In all the series of micro-element amendments, the extent and progress of colonisation by species of *Fusarium* were observed to be markedly diminished, whereas in the unamended control there was 100% colonisation.

The loss of viability of *Fusarium vasinfectum* from infected cotton stubbles buried in micro-element amended soils was observed to be hastened considerably over the control especially in the case of Al, Li, B, Mn and Zn, Zn being the most efficient.

13. **Sulochana, C. B. (Miss):** *Soil Conditions and Root Diseases: IV. The effect of Micro-elements on the occurrence of bacteria, actinomycetes and fungi in soils:* **Proc. Indian Acad. Sci. B. 36:** 19-33, 1952.

A study on the effects of certain micro-elements—Al, B, Co, Li, Mn, Mo, Ni and Zn—on soil bacteria, actinomycetes and fungi in the soil has been made.

The occurrence of these groups of micro-organisms were found to be significantly influenced by the amendments.

The bacterial numbers increased enormously in the Mn amended soils. This was closely followed by B, and by Zn, Mo and Li to a lesser extent. Ni, Al and Co exerted an adverse influence on the bacterial population of the soil.

The statistical interpretation of the results clearly indicated the marked significance of all the three factors, viz., Micro-elements, concentrations, incubation periods and also the following interactions: Micro-elements X Concentrations; Micro-elements X Incubation periods.

The numbers of actinomycete colonies were observed in greater numbers in soil samples amended with Li and to a lesser extent with Mn, B and Co.

The micro-elements with the exception of Zn and Ni increased considerably fungal numbers in the soil. Li showed fivefold increase in fungal numbers and as much as threefold increase in Mn, Mo, Co, B and Al as compared with the unamended control.

14. **Subramanian, C. V.:** *Studies on South Indian Fusaria: I.* Fusarium vasinfectum *Atk., with a note on its varieties and forms.* **Proc. Nat. Inst. Sci., India, 18:** 273-285, 1952.

The results are presented of a study of certain Fusaria isolated from wilted cotton plants and 'wilt-sick' cotton soil from Southern India. All iso-

lates studied belonged to the section Elegans and were similar morphologically but exhibited variation in regard to growth rate in culture and pathogenicity on cotton. The isolates were compared in detail with cultures of *Fusarium vasinfectum* Atk. and its varieties and forms obtained from the Centralbureau voor Schimmelcultures, Baarn, Holland. On the basis of the data obtained, which are presented and discussed in detail, all varieties and forms of *F. vasinfectum* Atk. recognised by Wollenweber and Reinking (1935) with the exception of *F. vasinfectum* Atk. v. *zonatum* (Sherb.) f.1 (Lk. *et* Bail). Wr. are considered synonyms of *F. vasinfectum* Atk. The Indian isolates are identified as *F. vasinfectum* Atk.

15. **Venkatram C. S.** and **Srinivasa Pai, K. V:** *Fertilization value of tank silts: II. Phosphorus and reproductive vigour of* Oryza sativa *L.* **Proc. Indian Acad. Sci., B. 36:** 81-84, 1952.

This work was a continuation of an earlier work by the authors (*Proc. Indian Acad. Sci. B.* 34, 1951). The P content of tank silts and its effect on the reproductive vigour of *Oryza sativa* has been discussed. Chemical analytical figures for silt soils is given and the relevance of these to earliness of flowering of rice plants in silt soil amendments is discussed.

16. **Satyanarayana, G.** and **Kalyanasundaram, R.:** *Soil Conditions and root diseases: V. Symptomatology of wilted cotton and red gram:* **Proc. Indian Acad. Sci. B. 36:** 54-58, 1952.

1. Wilt symptoms in cotton and red gram caused by the soil-borne pathogens *F. vasinfectum* and *F. udum* as seen by the naked eye and clearly made out by photographing with tricolour red filter on panchromatic film are recorded.

2. Wilt symptoms in cotton when sown in *F. vasinfectum* infected soils appear on the seventh day in variety M.9 and thirteenth day in variety K.2 after germination of the seeds as very distinct vein clearing discernible to the eye in cotyledonary leaves. Later, the first leaves also show vein clearing not clear to the eye but detectable by photographing with tricolour red filter.

3. Wilt symptoms in red gram by *F. udum* do not culminate in vein clearing as in cotton although there is a general and well-marked dechlorophyllation presenting almost a toxemic condition. This is first seen on the eighteenth day after germination.

4. The possibility of these vascular wilts interfering with the normal uptake of some of the essential chlorophyll forming heavy metals is discussed.

17. **Subramanian, C. V.:** *Fungi Imperfecti from Madras — I:* **Proc. Indian Acad. Sci. B. 36:** 43-53, 1952.

This is the first of a series of papers on the Fungi Imperfecti from Madras. One new species, *Beltrania indica* on dead pods of *Caesalpinia pulcherrima* is described. Five species, viz., *Torula herbarum, Zygosporium oscheoides Stachybotrys atra, Stachybotrys pulchra,* and *Corynespora cassiicola* are

reported from India for the first time. One species, *Memnoniella echinata*, is reported from Madras for the first time.

18. **Ramakrishnan, K.** and **Subramanian, C. V.:** *The Fungi of of India—A second supplement*: **J. Madras Univ. B. 22:** 1-65, 1952.

This supplement lists fungal records in India during the period 1938-51 inclusive. The number of fungi recorded during the period is 812 and the total number of fungi recorded so far in India is 3680. Sixteen generic names have been proposed during this period, one in the Phycomycetes, one in the Ascomycetes eleven in the Uredinales and two in the fungi imperfecti. Of these three in the Uredinales have been reduced to synonymy. The fungi are arranged in the alphabetical order under genera.

19. **Subramanian, C. V.** and **Ramakrishnan, K.:** Rostrospora, *a new genus of the Melanconiales*: **J. Madras Univ. B. 22:** 66-68, 1952.

Rostrospora gen. nov. is proposed as a new member of the Melanconiales, in the Fungi Imperfecti. It resembles *Colletotrichum* Corda, but differs from it in having conidia which are rostrate. The type of the genus is *Rostrospora ciliata* (Ramakrishnan, T. S. and K.) Subramanian and Ramakrishnan comb. nov. (Syn. *Colletotrichum ciliatum* Ramakrishnan, T. S. and K.)

20. **Kalyanasundaram, R.:** *Ascorbic acid and Fusarium wilted plants*: **Proc. Indian Acad. Sci., B. 36:** 102-104, 1952.

The results of this investigation indicate (i) dechlorophyllation and retarded growth which seem to precede the wilting of cotton and redgram plants by *Fusarium vasinfectum* and *F. udum* cause a decrease in the ascorbic acid content, (ii) Higher ascrobic acid content before wilting of cotton plants of inoculated series may be due to an increased metabolic activity of the plant in an attempt to resist the disease in the early stages; (iii) There is a rise in the reducing sugar of inoculated and diseased plants over the normal and it is likely that they are the precursors of ascorbic acid. (iv) There is a breakdown in the normal metabolism (photosynthetic activity) of wilt-affected plants, and there is experimental evidence permitting the assumption that this breakdown in the normal metabolism starts far in advance of the actual wilting of plants.

21. **Subramanian, C. V.:** *Fungi Imperfecti from Madras—II.* **Proc. Indian Acad. Sci., B. 36:** 160-168, 1952.

Arthrinium saccharicola, Dictyoarthrinium quadratum, Podoconis theae and *Lacellina graminicola* are recorded from India for the first time. *Camptomeris crataevœ* sp. nov. is described on leaves of *Cratœva religiosa*. One new genus, *Macraea* is proposed to accommodate *Macraea crataevae* (Syd.) Subramanian (= *Napicladium cratœvœ* Syd.) and *Macraea punjabensis* sp. nov.

22. **Chinnayya, E. J.:** *Colonization of plant debris by* Coprinus *species in soils.* **Nature, 170:** 252, 1952.

Isolation of Basidiomycetes from soils, particularly, *Coprinus* sp., by the root burial technique was facilitated by the addition of ammonia to bare garden soils as well as black cotton soil. Root pieces previously soaked in a 50% ammonia solution for one hour also resulted in the appearance of *Coprinus*.

23. **Mathew, K. T.:** *Growth-Factor requirements of* Pellicularia koleroga *Cooke in pure culture*: **Nature, 170: 889, 1952.**

Pellicularia koleroga isolated from *Coffea arabica* leaves grew well on synthetic culture media only when supplemented with fresh extracts of organic substrate like coffee leaf, malt, yeast or fungal mat. The fungus, therefore, exhibited growth-factor requirements and further experimentation with fractions of the B-complex vitamins indicated pronounced growth responses to the thiamine hydrochloride and biotin.

24. **Venkatram, C. S.:** *Soil bacteria and Chlamydospore formation in* Fusarium solani: **Nature, 170: 889, 1952.**

Two pure cultures of bacteria isolated from black cotton soils of southern India, one of them *Bacillus licheniformis*, (the other unidentified) significantly stimulated chlamydospore formation in the fungus *Fusarium solani* in sterile culture media. Both the presence of the bacterial cells and their metabolites induced this faculty in *F. solani*. These observations are of considerable interest as many Fusaria are known to survive in soils under adverse condition of microbial antagonism.

25. **Subramanian, C. V.:** *Studies on South Indian Fusaria: II. Fusaria isolated from black cotton soils.* **Proc. Nat. Inst. Sci. India, B. 18: 554-584, 1952.**

An account is given of the Fusaria isolated from black cotton soils collected from Udamalpet (Coimbatore District, South India). The soils were collected from areas known to be severely infested with the cotton wilt *Fusarium* (*Fusarium vasinfectum* Atk.) for years. The Fusaria isolated were:

Section Sporotrichiella

Fusarium poae (Peck) Wr.
F. chlamydosporum Wr. et. Rg.

Section Roseum

F. avenaceum (Fr.) Sacc.

Section Gibbosum

F. equiseti (Corda) Sacc.
F. scirpi Lamb. et Fautr.
F. scirpi Lamb. et Fautr. v. *acuminatum* (Ell. et. Ev.) Wr.
F. scirpi Lamb. et. Fautr. v. *caudatum Wr.*

Section Discolor

F. culmorum (W. G. Sm.) Sacc.

Section Elegans

F. oxysporum Schlecht.
F. vasinfectum Atk.

Section Martiella

F. javanicum Koord.
F. javanicum Koord v. *radicicola* Wr.
F. solani (Mart.) App. et. Wr.
F. solani (Mart.) App. et. Wr. v. *Martii* (App. et wr.) Wr.
F. solani (Mart.) App. et. Wr. v. *minus* Wr.
F. solani (Mart.) App. et. Wr. v. *striatum* (Sherb.) Wr.

26. **Subramanian, C. V.:** *Fungi Imperfecti from Madras. III*—Beltraniella *gen. nov.*: **Proc. Indian Acad. Sci., B. 36:** 223-228; 1952.

A new genus of hyphomycetes, *Beltraniella,* belonging to the Dematiaceae, occurring on dead and decaying leaves of *Odina wodier* has been described. The type species is *B. odinae*. The important characteristics of the fungus are: (i) the seta-like, thick-walled, dark-coloured, septate conidiophore bearing lateral branches, (ii) the "separating cells" borne singly at the apex of the spore-bearing cells; (iii) the top-shaped, subhyaline to faintly coloured, one-celled conidia produced acrogenecously and attached singly by their pointed ends to the tips of the "separating cells".

27. **Sulochana, C. B. (Miss):** *Soil Conditions and Root Diseases*: *VI. Germination of Conidia of* Fusarium vasinfectum *in Micro-element amended soils*: **Proc. Indian, Acad. Sci. B. 36:** 229-233, 1952.

A study of the germination of micro—and macro-conidia of *Fusarium vasinfectum* introduced into the wilt infected soils amended with micro-elements was made employing modified Cholodny's slide technique.

Statistical analysis of the results showed the micro-elements, concentrations, incubation periods and the interacting factors to be highly significant from the point of view of retardation of conidial germination.

Percentage germination of the conidia in all the amended soil samples, excepting manganese 50 p. p. m., was much lower than that of the unamended control soil. Zinc, molybdenum, lithium, aluminium, nickel, boron, cobalt and manganese were correspondingly inhibitive in the order mentioned.

28. **Sulochana, C. B. (Miss):** *Soil Conditions and Root Diseases*: *VII. Response of Cotton plants to Micro-element amendments and its relation to disease development*: **Proc. Indian Acad. Sci., B. 36:** 234-241, 1952.

In the experiment conducted to study the response of cotton plants to micro-element soil amendments zinc and manganese were found to be beneficial for the growth of cotton plants. Boron, lithium and molybdenum were toxic.

Cent per cent germination of cotton seeds was recorded in the control and all the treated soils except in the case of boron treatments. When the seeds were soaked in micro-element solutions prior to sowing in soil, only the nickel-treated seeds showed scanty germination.

Studies on the pathogenic potentialities of *Fusarium vasinfectum* on a susceptible variety of cotton showed that zinc was effective in reducing the wilt incidence, whereas manganese aggravated the incidence of wilt.

29. **Subramanian. C. V.:** *Fungi isolated and recorded from Indian soils*: **J. Madras Univ. B. 22:** 206-222, 1952.

This list embodies listing of species alphabetically under genera, the genera having been alphabetically arranged under four classes: Phycomycetes, Ascomycetes, Basidiomycetes (Hymenomycetes and Gasteromycetes, separately) and the Fungi Imperfecti. The species listed include not only those isolated from Indian soils and brought into artificial culture but also those found growing and producing their fructifications directly in or on soils. Total number of genera and species recorded is 141 and 410 respectively.

30. **Ramakrishnan, K.** and **Subramanian, C. V.:** *The Fungi of India—A second supplement*: **J. Madras Univ. B. 22:** 163-182, 1952.

This is the second part of the paper listed earlier as serial number 18 above and deals with list of hosts and substrata.

31. **Venkataramani, K. S.:** *A preliminary study of some intervarietal crosses and hybrid vigour in* Hibiscus esculentus, *L.* **J. Madras Univ. B. 22:** 183-200, 1952.

Six varieties and seven intervarietal crosses of "bhendi", *Hibiscus esculentus*, were studied in some detail. The varieties differed from one another in many respects. The immediate effect of crossing on the height, nature of leaf-lobing and petal spot, earliness in flowering, fruit and yield of fruit per plant was determined and the various observations made are detailed in the text.

The hybrid plants were intermediate between the parental ones in height, and they flowered as early as or earlier than the early flowering parent. The crosses produced fruits which were either intermediate between the parental ones in size or slightly longer. In general, they produced more fruit per plant than the parents and increase in total yield was obtained in five crosses over both the parents, the improvement ranging from 5·4 to 14·5 per cent over the better parent and 3·6 to 59·3 per cent over the poorer parent. No improvement over both the parents was registered in one case.

32. **Sadasivan, T. S., Lakshminarayanan, K., Sanjivi, K. S., Subramanian, R.** and **Krishnaswamy, N.:** *Studies in Allergic Asthma, Part I, Hypersensitivity to field beans (Dolichos) and House Dust*: **Indian J. med. Res., B. 40:** 373-385, 1952.

Many common food and other allergens were tested in a critical experimental survey on asthmatic patients in Madras as a collaborative effort between the University Botanical Department and the Chest clinic of the Government Stanley Hospital, Madras. The allergent tested were: Black-gram (*Phaseolus mungo*), Red gram (*Cajanus cajan*), Field beans (*Dolichos lablab*), House dust, Egg, Tea, Milk, *Aspergillus niger, Alternaria solani, Alternaria palandui, Alternaria macrospora,* Green gram, Bran, *Penicillium notatum,* and *Aspergillus oryzæ.* The report summarises the findings on 32 patients desensitized with the allergens. Field bean allergen was found useful in the majority of cases in giving a positive protection against subsequent attacks and it is possible that a positive allergy to field bean reflects an allergy to other beans whose proteins may have a chemical resemblance to the field bean allergen.

33. **Srinivasa Pai, K.V.:** *A note on the determination of reducing sugars*: **J. Madras Univ., B. 22:** 201-205, 1952.

A volumetric procedure for determining reducing sugars which finds application in biological work is outlined. The effect of some of the common substances used in the preparation of synthetic nutrient media on the oxidation of sugars by alkaline ferricyanide has been studied.

34. **Agnihothrudu, V.:** *Soil Conditions and Root Diseases: VIII. Rhizosphore microflora of some of the important crop plants of South India:* **Proc. Indian Acad. Sci., B. 37:** 1-13, 1953.

1. Greater accumulations of fungi, bacteria and actinomycetes in the rhizosphere than in the control soils were recorded.

2. A decreasing order of 'rhizosphere effect' as follows was noticed: Bacteria > fungi > actinomycetes.

3. Maximum 'rhizosphere effect' on bacteria was noticed during the time of flowering. Increase in fungal numbers after flowering was recorded.

4. Changes in the total fungal numbers correspond with the changes in numbers of Aspergilli and Penicillia, both in the dilution plates and the root platings.

5. The absence of certain predominant fungi like *Fusarium* spp., *Macrophomina phaseoli, Neocosmospora vasinfecta* in the rhizosphere dilutions emphasizes the necessity of assessing the physiological state in which they are extant in the rhizosphere.

6. *Sorghum* stands unique in that its rhizosphere had highest numbers of fungi among the non-legumes and highest numbers of actinomycetes among all the plants studied. The potential root pathogens so often encountered in the rhizosphere of other plants were absent in the case of *Sorghum.*

35. **Subramanian, C. V.:** *Fungi Imperfecti from Madras, IV.* **Proc. Indian Acad. Sci., B. 37:** 96-105, 1953.

Cephaliophora irregularis, Dendryphion laxum and Dictyosporium prolificum, are recorded. *Lacellinopsis sacchari,* gen. et. spec. nov. are described.

36. **Subramanian, C. V.** and **Ramakrishnan, K.**: Petrakomyces, *a new genus of the Sphœropsidales*: **Proc. Indian Acad. Sci., B. 37:** 110-113, 1953.

Petrakomyces indicus gen. et. spec. nov. has been described. The new genus is compared with *Ciliochora* Hoehnel and *Ciliophora* Petrak.

37. **Srinivasa Pai, K. V.**: *Carbon, Nitrogen and pH relationships to growth of soil Fusaria in culture.* **Proc. Indian Acad. Sci., B. 37:** 131-148, 1953.

The reaction of the medium with the growing of *F. vasinfectum* and *F. moniliforme* cultures was influenced by the form and source of nitrogen metabolised by them. The hydrogen-ion concentration of media inoculated with *F. vasinfectum* was, however, higher than in media inoculated with *F. moniliforme* at all levels of nitrogen supplied. With the exception of $(NH_4)_2SO_4$ series, the others, viz., KNO_3, urea and peptone series, brought about a decrease in pH of the media during the initial 6 to 9 days growth of the fungi and subsequently increased the pH towards alkalinity or neutrality. In the case of $(NH_4)_2SO_4$ series this lowering of pH persisted throughout. Both Fusaria grew at a considerably low pH of 2·1.

Amount of mycelial mat produced during the entire period of incubation was higher in *F. moniliforme* cultures than *F. vasinfectum* cultures with all sources of nitrogen employed. Both Fusaria made best growth in media containing KNO_3 at 140 mg. nitrogen % level. Mat weights in ammonium sulphate series were inversely proportional to the concentration of the salt. In *F. moniliforme,* however, it was directly proportional up to 140 mg. nitrogen % level. Increases in concentration of peptone as a source of nitrogen in culture media (up to level 140 mg. nitrogen %) progressively increased mat weight of *F. vasinfectum* cultures; this increase in growth was directly proportional to the concentration of the nitrogen source used in the case of *F. moniliforme* series.

Percentage nitrogen in fungal mat of the two Fusaria was dependent on the age of culture and source of nitrogen supplied and differed in the two species. Accumulation of nitrogen in the growing fungal mat was more when organic sources of nitrogen were supplied to the substratum, than when inorganic sources were supplied. Almost the entire quantity of nitrogen supplied to the substratum in the form of urea and peptone at 28 mg. % concentration was stored up in the fungal tissue of Fussaria. This was, however, not the case when inorganic sources of nitrogen were supplied.

Sugar in culture media, containing different concentrations of KNO_3 as source of nitrogen, was depleted completely by 21 days' growth of both Fusaria. In media containing ammonium sulphate as a source of nitrogen, considerable amount of sugar was detected even after 21 days incubation of the Fusaria. No direct correlation existed between the rates of sugar depletion by the Fusaria when peptone and urea formed the sources of nitrogen. Ammonia formed in the substrate from media containing nitrate and organic nitrogen sources was the product of partial autolysis of the fungus.

The general conclusions are that both Fusaria displayed markedly different physiological relationships; this was brought out by their rates of growth, by their nitrogen and sugar utilization and by the varying nature and extent of hydrogen-ion change of the media caused by them.

38. **Subramanian, C. V.** and **Srinivasa Pai, K. V.:** *Relation of Nitrogen to growth and sporulation of* Fusarium vasinfectum *Atk.* **Proc. Indian Acad. Sci., B. 37:** 149-157, 1953.

The effect of four different nitrogen sources, viz., potassium nitrate, ammonium sulphate, ammonium nitrate and urea, each at four different levels, viz., 28 mg., 70 mg. 140 mg., and 210 mg. per 100 ml. of medium, on the growth, sporulation, nitrogen accumulation, and sugar and nitrogen depletion from media by *Fusarium vasinfectum* has been studied. The results are presented in detail and discussed. The main conclusions are summarised under "Results".

39. **Swamy, B. G. L.:** *On the floral structure of* Scyphostegia: **Proc. Nat. Inst. Sci. India, B. 19:** 127-142, 1953.

A critical re-examination of the male and female flowers of *Scyphostegia borneensis* Stapf reveals the following structural features:

(i) The male flower has four whorls of appendages, the first whorls from outside representing the perianth, the three outer lobes sepaline, the three inner petaline; appendages of the third whorl constitute three 'glands' placed opposite to the petals; the innermost whorl is made up of three syngenecious stamens, lying again in a superposed seriation with the petal and glands.

(ii) The female flower consists of three whorls of appendages, the outer two being homologous with the perianth of the male flower; the innermost whorl is the multicarpeliary, unilocular gynoecium itself, lodging many ovules.

There are objections to regard the appendages belonging to the third whorl of the male flower as petals. Arguments are provided to interpret these structures as 'glands' that have been derived from microsporophylls. Theoretical stages in their phylogenetic derivatives are reconstructed.

Understanding of the structure and nature of the essential organ of the female flower by previous botanists is shown to be erroneous. What they interpreted as 'disc', or 'receptacle', or 'corolla' is demonstrated to be no other structure than the gynoecium; what they thought to be 'carpels', or 'flowers' are shown to be the ovules. Hypothetical series of probable phylogenetic changes involved in the derivation of the extant situation in the gynoecium of *Scyphostegia* is illustrated.

In view of these significant re-interpretations of structure and morphology, the taxonomic descriptions of the family, genus, and species are amended.

From a totality of evidence obtained from a study of morphological and anatomical characters, any relationship of the family Scyphostegiaceae, either with the Monimiaceae, or with the Urticaceae, or with any of the ranalian families is strongly negated.

40. **Swamy, B. G. L.:** *Comments on* Ascarina Alticola Schlechter: **Proc. Nat. Inst. Sci. India, B. 19:** 143-147, 1953.

A critical re-examination of *Ascarina* Schlechter from anatomical and morphological points of view and a comparison of the data obtained therefrom with other species of the genus *Ascarina* and also with other representatives of the Chloranthaceae indicates that the species under consideration exhibits numerous significant differences that necessitate its exclusion not only from the genus *Ascarina,* but also from the family. On the other hand, the species proves to be congeneric with *Paracryphia* of the Eucryphiaceae.

41. **Swamy, B. G. L.:** Sarcandra irvingbaileyi, *a new species of vesselless dictoyledon from South India*: **Proc. Nat. Inst. Sci. India, B. 19:** 301-306, 1953.

An examination of vast collections of the genus *Sarcandra,* deposited in several herbaria of the United States of America, Great Britain, and India indicate that specimens coming from South India differ significantly in the exomorphic floral characters from other recognized species of the genus, *S. glabra* and *S. hainonensis,* and therefore warrant the establishment of a new species for the accommodation of these plants.

Attention is drawn to the vesselless nature of the xylem of these plants, and its structural characteristics are described. The important features, together with data obtained from nodal anatomy and from comparative morphology fall within the range of variability exhibited by the genus *Sarcandra.* However, the specimens distinguish themselves significantly from other known species of the genus in the possession of an unusually large stamen and of a marked cushion shaped deformation on the abaxial of the carpel.

The name *Sarcandra Irvingbaileyi* sp. nov. is proposed for the reception of these plants and the diagnostic features of the species are described, together with annotations of herbarium specimens examined.

42. **Swamy, B. G. L.:** *Some observations on the Embryology of* Decaisnea insignis *Hook et. Thoms.*: **Proc. Nat. Inst. Sci., B. 19:** 307-310, 1953.

Decaisnea insignis agrees with *Holboellia latifolia* and *Akebia quinata* in the possession of krassinucellate and in the formation of a parietal cell which in turn produces three or four layers of similar tissue. As in *Akebia quinata,* Polygonum type of development characterizes the female gametophyte of *Decaisnea.* Organization of a binucleate and secondary type of tapetum, simultaneous method of divisions in the microspore mother cell, development of a single layered endothecium, and two-celled shedding condition of the pollen, are characters shared both by *Akebia* and *Decaisnea.*

The location of the secondary embryo sac nucleus in *Decaisnea* is characteristically nearer to the antipodal cells than to other component cells of the embryo sac, a situation that appears to be paralleled in *Akebia* as can be judged by Vesler's illustrations. In *Decaisnea,* the division of the primary endosperm nucleus is followed by the formation of a wall, thereby halving the embryo sac into a larger micropylar and a smaller chalazal chambers.

Both the chambers contribute towards the building up of endosperm. Towards later stages the rate of divisions of endosperm cells situated nearest to the chalazal end appear to become accelerated. Four to six cell layers inclosed by the base of integuments differentiate into an opaque, darkly staining pad of tissue during post fertilization development.

43. **Swamy, B. G. L.:** *On the relation of* Chloranthus Kiangsiensis *to the genus* Chloranthus: **Proc. Nat. Inst. Sci., India, B. 19: 311-312, 1953.**

The data obtained through a critical examination of taxonomic and morphological characters of *Chloranthus kiangsiensis* Metcalf warrants the exclusion of this species not only from the genus, but from the family Chloranthaceae.

44. **Swamy, B. G. L.:** *A Taxonomic revision of the genus* Ascarina *Forst.*: **Proc. Nat. Inst. Sci. India, B. 19: 371-388, 1953.**

In the monographic study, seven species and one variety of *Ascarina* are recognised. *A. reticulata* Merr., *A. subfalcata* J. W. Moore, and *A. raiteensis* J. W. Moore are reduced to synonymy under *A. philippinensis* C. B. Rob., *A. lanceolata* Hook f., and *A. polystachya* Forst. respectively. A new species, *A. Maheshwarii* and a new variety, *A. lanceolata* v. *Smithii* have been proposed.

45. **Subramanian, C. V.,** and **Ramakrishnan, K.:** *On the nature of the spore-appendage in* Neottiospora *Desm.* **Proc. Indian Acad. Sci., B. 37: 228-231, 1953.**

The nature of the appendage in *Neettiospora* is described as: (i) there is *only one* appendage for the spore, (ii) the appendage is mucoid and evanescent; and (iii) the appendage is in the form of an inverted hollow cone with hyaline, thin walls.

46. **Kalyanasundaram, R.** and **Lakshminarayanan, K.:** *Rooting of cut shoots of cotton in culture filtrate of* Fusarium vasinfectum: **Nature, 171: 1120, 1953.**

The dialysed culture filtrate of *Fusarium vasinfectum* produced typical wilt symptoms to cotton plants when applied neat but as dilution produced toxaemia but induced rooting in cut shoots of the plant. Inactivated toxin by heat treatment (autoclaving at 15 lb. pressure) induced profuse rooting in cut shoots of cotton at all concentrations and in no case showed any wilt symptoms. It is postulated that dialysed culture filtrate of *F. vasinfectum* contains two or more factors: (i) a thermolabile factor producing wilt symptoms at higher concentrations, and (ii) a thermostable factor stimulating vigorous rooting in cut shoots even at dilutions.

47. **Subramanian, C. V.:** *Fungi Imperfecti from Madras, V.* Curvularia: **Proc. Indian Acad. Sci., B. 38: 27-39, 1953.**

This paper is a systematic account of some species of *Curvularia*. Two new species, *C. indica* and *C. palmarum* are described. Eight other species

are recorded. *C. maculans, C. lunata, C. andropogonis C. pallescens, C. trifolii, C. inaequalis, C. falcata,* and *C. uncinata.* Of these all species except *C. lunata* are new records for India. The only other species known from India is *C. penniseti.*

48. **Venkataramani, K. S.:** *Some observations on blossom biology and fruit formation in* Hibiscus esculentus: **J. Madras Univ. B. 23: 1-14, 1953.**

The data presented herein on certain floral characters and development of fruit in six varieties of the "bhendi", *Hibiscus esculentus L.*, reveal that: (1) the flower, in general, takes 20-22 days to reach the maximum size from the time of the initiation of the bud, (ii) the size of the flower bud a day prior to anthesis appears to be a varietal character; (iii) the anthers dehisce soon after the unfurling of the twisted corolla and the stigma remains receptive as long as the flower is open, (iv) under field conditions, cross-pollination is found to be the general feature, while self-pollination is by no means totally absent, (v) natural cross-fertilisation takes place to an appreciable extent, especially when two or more varieties are closely planted, (vi) the pollen grains lose their viability considerably even within 24 hours of the dehiscence of the anthers when stored at the room temperature (30°C.), but they remain viable up to about 144 hours when stored over $CaCl_2$ at 0° C., (vii) in the variety "P. 13", the fruit attains its maximum length by about the tenth day after pollination, i.e., long before the maximum weight is reached, the fruit being in a fit condition for harvest as vegetable by the seventh day, and that (viii) unequal deposition of pollen on stigmatic lobes may result in curving of fruit in varieties which normally produce straight fruits.

49. **Mathew, K. T.:** *Thiamine, its intermediaries and growth of* Corticium microsclerotia (Matz) Weber: **Proc. Indian Acad. Sci., B. 38: 1-9, 1953.**

A pure culture of the fungus *Corticium microsclerotia* (Matz) Weber, obtained from the Centralbureau voor Schimme Cultures, Baarn, Holland, was found to be thiamine heterotrophic, when cultured on a glucose nitrate medium.

Under the cultural conditions employed the fungus was observed to reach its maximum growth in about 15 days, in the presence of an optimum amount of 2·0μ g. of thiamine per flask, containing 20 ml. of medium.

The fungus did not require the intact thiamine molecule as such and grew almost equally well when supplied with an equimolar mixture of thiazole and pyrimidine. The fungus also had the ability to slowly complete the synthesis of thiamine from pyrimidine alone, but not from thiazole.

50. **Ramakrishnan, K.:** *Ascomycetes from South India — I.* **Proc. Indian Acad. Sci., B. 38: 118-124, 1953.**

Four new species of Ascomycetes are described from Southern India. *Chaetomium rufum* on wet straw, *Polyclypeolum salvadorae, Phyllachora kambakkamensis* and *Phyllachora tetraspora* on living leaves of *Salvadora persica, Ochna* sp. and *Polyalthia longifolia* respectively.

51. **Ramakrishnan, K.:** *Ascomycetes from South India — II.* **J. Madras Univ. B. ~~24: 145-47~~, 1953.** (23?) (144-47?)

Two new ascomycetes, viz., *Julella sarcostemmatis* and *Massarina sarcostemmatis*, both on living stems of *Sarcostemma brevistigma*, are described.

52. **Subramanian, C. V.** and **Ramakrishnan, K.:** Plagionema, *a new genus of the Sphaeropsidales*, **J. Indian bot. Soc., 32, (3): 131-36, 1953.**

Plagionema indica gen *et.* sp. nov. is described as a new member of the Sphaeropsidales. It is reported to occur as a saprophyte on dead leaves of *Azadirachta indica, Bignonia* sp. *Achras sapota, Mangifera indica, Psidium guajava, Swietenia mahagoni, Ficus sp. Zizyphus oenoplia, Lantana aculeata, Hugonia mystax* and *Ficus bengalensis*, and a dead leguminous pod.

53. **Subramanian, C. V.:** Koorchaloma, *a new genus of the Tuberculariaceae*: **J. Indian bot. Soc., 32, (3): 123-26, 1953.**

Koorchaloma madreeya gen. et. sp. nov. is described as a new member of the Tuberculariaceae. The type collection is on dead culms of *Oryza sativa.*

54. **Lakshminarayanan, K.:** *Mechanism of* Fusarium *wilts of plants*: **Proc. Indian Acad. Sci., B. 38: 1953.**

This is a discussion of the two well-known theories put forward to explain the mechanism of wilt in plants caused by *Fusarium* spp.—the "vessel plugging" theory which has found support from Scheffer and Walker and the toxin theory for which much evidence in favour has come from the work of Gäumann. The writer favours a combination of the two theories as a satisfactory explanation of the wilting mechanism, and it is contended that wilting is closely linked up with the enzymic set-up and respiratory and other changes brought about in the host.

Madras University: Department of Zoology
Abstracts of Papers Published, 1951-53

1951

1. **Gnanamuthu, C. P.:** *Three new species of Lernaeid copepods parasitic on South Indian Fish*: **Ann. Mag. Nat. Hist. Ser. 12, 4: 77-86, 1951.**

Full descriptions of three parasites, *Peniculus trichiuri* N. Sp. (collected from *Trichiurus haumela, T. savala* and *T. muticus.*) .*Peniculus theraponi* sp. n. (collected from the dorsal and pectoral fins of *Therapon jarbua.*) and *Peniculus sciaenae* sp. n. (found on the pectoral fin of *Sciaena albida*) are described full.

2. **Gnanamuthu, C. P.:** *Perissopus manuelensis N. sp. A pandarine copepod parasitic on Mustelus manazo Bleeker.* **Spolia zeylanica, 26: 9-12, 1951.**

Perissopus manuelensis, a new species parasitic on *Mustelus manazo* is described fully and is compared to other known species. A tabular comparison with *P. communis* Rathbun, *P. dentatus* Streenstrup & Lutken, and *P. crenatus* Leigh-Sharpe is given.

3. **Gnanamuthu, C. P.:** *Brachiella trichiuri N. sp. A copepod parasitic in the mouth cavity of the ribbon fish.* **Ibid., 13-15, 1951.**

Brachiella trichiuri, a new species collected from the mouth cavity of *Trichiurus haumela,* is fully described.

4. **Gnanamuthu, C. P.:** *Two new species of the copepods of the genus Peniculus parasitic on Madras fishes*: **Rec. Indian Mus., 59: Pt. 2, 221-226, 1951.**

Peniculus stromatei from caudal and dorsal fins of *Stromateus* niger and Peniculus scomberi from the fin rays of *Scomber microlepidotus* are described fully.

5. **Gnanamuthu, C. P.:** *Studies on a lernaeid copepod, Cardiodectus anchorellae. Brian and Gray*: **Proc. zool. Soc., London, 121: 237-252, 1951.**

A redescription of this species is given with notes on its larval stages and anatomical features. The frequency of infection, the attachment and

the dependence of the parasite on the host, as well as the respiratory and osmotic relations of the parasite with the surrounding medium are briefly discussed. An account of the structure of the body wall, the gut, the vascular, nervous and reproductive systems is given.

6. **Gnanamuthu, C. P.:** *Lernaea chackoensis N. sp. A copepod parasitic on two Madras fishes.* **Parasitology, Cambridge, 41:** 143-147, 1951.

This new species collected from *Osphronemus goramy* Lacépedé and *Catla catla* cuv. & val. is described fully. (The formation of different patters of cephalic arms, in different parasites infecting the same fish host, shows that classification cannot be based on the branchings of the cephalic arms.)

7. **Gnanamuthu, C. P.:** *New copepod parasites of Sharks.* **Ann. Mag. Nat. Hist., 4:** 1236-1256, 1951.

Three parasites collected from the skin of carcharind sharks caught off Rameshvaram are described. These are *Albion alatus* sp. n., *Pandarus longus* sp. n., and the hitherto undescribed male of *Perissopus manuelensis* Gnanamuthu.

8. **Gnanamuthu, C. P.:** *Notes on the life history of Lernaea chackoensis*: **Parasitology, Cambridge, 41:** 148-155, 1951.

The naupliar, metanaupliar and copepodite stages are described. The copepodite which appears three days after the hatching of the egg. dies in 24-32 hours if it does not infect a fish host. It is not able to settle on the adult host—the goramy. The intermediate fish hosts were determined by experimentally infecting different small sized fishes usually found along with goramy.

Oryzias rubristigma and *Barbus stigma appear* to be easily infested. The fifth copepodite stage is reached 10 day's after hatching. Sexes differentiate. The mature female 0·91 mm. long infects the final fish host and in two days grows to 3·8 mm. in length, develops the characteristic cephalic arms and becomes a blood feeding adult. The male dies 12 days after hatching. The accelerated development of this tropical form is compared to the Japanese and American species.

9. **Gopalakrishnan, V.:** *A note on the chemical composition of the Penaeid Prawns of Madras*: **Curr. Sci., 20:** 331, 1951.

The chemical compositions of both males asd females of four different species are tabulated. The differences due to sex are irregular and not marked.

10. **Krishnamoorthi, B.:** *Studies on the osmotic properties of the eggs and larvae of a brackish-water Polychaete, Marphysa gravely, Southern*: **Proc. Indian Acad. Sci., B. 34:** 199-209, 1951.

Experiments regarding the effects of the hypotonic and hypertonic media on the volume changes. It is concluded that the eggs are passive as far as

the transport of the salts and water are concerned. The rate of mortality observed when eggs with jelly and without jelly were subjected to hypotonic media is recorded and the conclusion that the envelope of jelly acts in the same way as an impermiable membrane in the case of eggs of other animals is drawn.

The effects of hypotonic media on the volume of larvae is described and the role played by the secretory organs and their importance is osmoregulation is indicated.

11. **Krishnaswamy, S.:** *Notes on the undescribed males of two species of copepods*: **J. Wash. Acad. Sci., 41**: 75-77, 1951.

The males of *Centropages trispinosus* Sewell and *Diosaccus truncatus* Gurney are described fully.

12. **Vijayaraghavan, P.:** *The food of the ribbon fishes of Madras*: **J. Madras Univ., B. 21**: 282-287, 1951.

Stomach contents of *Trichiurus hausmela* and *T. savala* belonging to the 10 and 20 inches size groups are analysed and seasonal fluctuations in their chief food items are briefly discussed. Variations in the rate of feeding are probably correlated with the physiological requirements of the fish. Variations in the volumes of the chief food items consumed may be related to their dearth or abundance in the environment.

13. **Vijayaraghavan, P.:** *Food of the rainbow sardine (Dussumeira acuta Cuv. and Val.)*: **Ibid.** 282-287, 1951.

The stomach contents of the 4" and 5" size groups of *Dussumeiria acuta* (Cuv. and Val) are analysed and fluctuations in the favourite items of diet are discussed. While fluctuations in the rate of feeding of the fish are probably correlated with its growth, they are not influenced by the fluctuations in its favourite items of diet occurring in the environment.

14. **Krishnaswamy, S.:** *Three new species of sand-dwelling copepods from Madras Coast*: **Ann. Mag. Nat. Hist. Ser., 12. 4**: 273-280, 1951.

Full descriptions of three new species of sand-dwelling copepods, *Leptastacus nichollsi, Leptopsyllus madrasensis* and *Paramesochra longietosa* are given.

15. **Krishnaswamy, S.:** *The development of Harpaticoid copepod Macrosetella gracilis (Dana)*: **J. Madras Univ., B. 21**: 256-271, 1951.

The eggs as well as the six naupliar and six copepodite stages of *M. gracilis* are described, tracing the gradual differentiation of the structure of the appendages in the copepodite stages.

1952

16. **Gnanamuthu, C. P.:** *A simple device for measuring the volume of an aquatic animal*: **Nature, 170:** 587-588, 1952.

A new apparatus, suitable for the determination of the volume of small, live, aquatic animals is described.

17. **Krishnan, G.:** *On the Nephridia of Nereidae in relation to habitat*: **Proc. Nat. Inst. Sci., India, 18:** 241-255, 1952.

Nephridia of three species of Nereidae taken from waters of different salinities are described. The nephridia of *Lycastis indica* lie in the body cavity on either side of the gut and are larger in size than in the other two species. The nephridial canal is in the form of loops and is considerably lengthened.

In *Nereis chilkensis*, the nephridia lie at the entrance to the parapodial cavity, and are small in size, formed of connective tissue through which runs a coiled nephridial canal. Blood supply not so rich as in the previous species.

In *Perinereis nuntia* the nephridia are smaller in size and the nephridial blood vessels are poorly developed. In *Lycastis* acclamatised to sea-water, the blood supply to nephridium undergoes dimunition. The nephridia of the three species are compared and variations in size and vascularisation are discussed in the light of their probable relation to osmoregulation.

18. **Daniel, A.:** *The respiratory mechanism of Balanus tintinnabulam*: **J. Madras Univ., B. 22:** 261-267, 1952.

The opercular valves and their muscles aiding respiratory movements are described. The contraction of the lateral depressor muscle which takes half a second results in the separation of the opercular valves of one side from those of its pair at the occludent margin and opening the entrance to the mantle cavity which is kept in this position.

19. **Daniel, A.:** *A new barnacle, Lepas bengalensis from Madras*: **Ann. Mag. Nat. Hist., 5:** 400-403, 1952.

Full description of this new species collected at Madras is given.

20. **Gopalakrishnan, V.:** *Food and feeding habits of Penaeus indicus M. Ed.*: **J. Madras Univ., B. 22:** 69-75, 1952.

The stomach contents of 380 specimens of *Penaeus indicus* have been analysed with a view to study the food habits of the animal. Although vegetable matter and crustaceans form the bulk of the food items, the presence of other animal matter indicates omnivorous habit. A few experimental data on feeding is also given.

21. **Sebastian, V. O.:** *A new species of synascidian from Madras*: **Curr. Sci., 21:** 316-317, 1952.

This deals with a further verification of a species of *Polyclinum* described by the author in the *Jour. Madras Univ.* 14 2, 1942. This is found to differ from the hitherto known polyclinids in the presence of 12 anterior ectodermal ampullae, as against the 8 which is the usual number recorded. This form is given the name *Polyclinum madrasensis.*

22. **Sebastian, V. O.:** *A case of natural adaptability of Anopheles larvae to seawater;* **Curr. Sci., 22:** 23. 1952.

An account of *Anopheles* larvae breeding in sea-water at the level of the breakers is given. Indian Anophelines though known to breed in brackish waters are not recorded from sea-water. Here, the salinity was 32·68% and pH 8·3. The two larvae got were of the 1st instar stage, and they passed through all metamorphosing stages and became adults. The species were males and were found to be *A. subpictus* or *A. vagus,* because males of both have the same features. This occurrence is taken to be a case of adaptability not only to water of high salinity, but also to a medium of violent agitation.

23. **Pampapathi Rao, K.:** *Significance of variation in Ptychodera flava.* **Evolution, U. S. A., 6:** 342-343, 1952.

The variations in *Ptychodera Flava* are discussed. It is suggested that the gradual accumulation of differences though primarily of the nature of variations, may lead a variety along a path of speciation.

24. **Ramalingam, K.:** *Six new species of Trematodes belonging to the genus Prices Chauhan:* **Rec. Indian Mus., 59:** 337-348, 1952.

Six new species collected from *Cybium guttatum* are described together with a key for the genus. There are *Prices tetracanthum, Prices armatum* n. sp., *P. tricanthum* n. sp., *P. melane* n. sp., *P, minutum* n, sp, and *P. robustum* n. sp.

25. **Krishnaswamy, S.:** *Some new species of copepods from Madras coast:* **Rec. Indian Mus., 59:** Pts. 3 and 4; 321-336, 1952.

Five new species (one calanoid and four cyclopoids) of pelagic copepods are fully described. These are *Labidocera bengalensis* n. sp., *Corissa indica* n. sp., *Kelleria rubimaculata* n. sp. (from Madras Plankton), *Macrochiron (Paramacrochiron) ornatus* n. sp. (from Madras Plankton) and *Saphirella enigmatus* n. sp. (from the plankton collected at Madras as well as Krusadai Is.). A review of the 'genus' *Saphirella* is also given.

26. **Krishnaswamy, S.:** *A new species of Hapacticoid copepod from Madras plankton:* **J. zool. Soc, India, 4:** 173-175, 1952.

Alteutha sewelli, a new species, collected from Madras plankton is fully described.

1953

27. **Gnanamuthu, C. P.:** *Three Lernaeid copepods parasitic on S. Indian fishes*: **J. Parasitology, New York, 39:** 1-9, 1953.

A redescription of *Lerneaenicus hemiramphi* Kirtisinghe is given with notes on its anatomy. Two new species of this genus. *Lerneaenicus nemipteri* n. sp. from *Nemipterus marginatus* c.v. (*Syngaris bleekeri* Day) on the lateral muscles, *Lerneaenicus stromatei* n.sp.—attached to the blood vessels of *Stromateus niger* Bloch are also described. A description of the metamorphosed larva is also given.

28. **Krishnan, G.:** *On the cuticle of the scorpion, Palamneus swammerdami*: **Quart. J. Micros. Sci., 94:** 11-21, 1953.

The culticle shows the same fundamental layers as that of insects, consisting of a thin outer epicuticle, and a thick inner endocuticle. The outer layers of the latter are transformed by hardening into an amber coloured exocuticle. The chemical characteristics of the constituent layers of the cuticle in different regions are described and it is shown that proteins impregnating the endocuticle during hardening appear to be different from those described in insects and possess resistant properties. The exocuticle in addition to giving evidence of tanning indicates the presence of disulphide bonding. A similar indication is obtained in the epicuticle. The mode of hardening of the cuticle is discussed and compared with similar processes in other arthropods.

29. **Sebastian, V. O.:** *The development of Herdmania pallida (Heller)*: **Proc. Indian Acad. Sci., B. 37:** 174-187, 1953.

The eggs of *Herdmania pallida* were artificially fertilised and development traced upto the emergence of the tadpole larva and final fixation. The egg is small and not heavily yolked. The sea at Madras has a temperature of 27°-29°C. Gastrulation is embolic and takes place in 110 minutes. The free-swimming larva is liberated is 8 hrs. Free-swimming period lasts for 3 to 3½ hrs. Six ampullae are developed during fixation.

The outstanding feature is the presence of three sensory organs inside the sensory vesicle, viz., two unicellular ocelli of which one is small, and an otolith. This is the first record of the occurrence of three sensory organs in an ascidian larva. The unique nature of the sensory organs has helped to decide the polyphyletic origin in ascidians.

The question of standard sensory equipment of ascilian tadpolle is discussed. An hypothetical ascidian tadpole is suggested, which ought to have possessed three unicellular ocelli and one otolith. During the course of evolution the ocelli have fused to form a complex ocellus with 3 lenses and associated structures, the latter again undergoing secondary degenerative changes. Another possibility is degeneration of ocelli without fusion, the ololith alone remaining. The tendency towards such degeneration is indicated in the diminished nature of one of the ocelli in *H. pallida*.

30. **Gopalakrishnan, V.**: *Seasonal fluctuations in the fat content of the Prawn, Penaeus indicus M. Ed.*: **J. Madras Univ., B. 23: 193-202, 1953.**

The seasonal fluctuations in the fat contents of the prawn are reported. Four different arbitrary length groups were chosen as fluctuations in the fat content during the course of the year estimated. Maximum percentages of fat occur during the months of November, December and January.

31. **Pampapathi Rao, K.**: *The development of Glandiceps (Enteropneusta; Spengelidae)*: **J. Morphology, Phil. 93: 1-17, 1953.**

The development of a species of *Glandiceps*, presumably a new species, *G. stiasnyi*, is described. All stages from the early (Muller) Tornaria to young burrowing worms are described and the resemblance of this to other Tornaria is presented, emphasising the similarities of organogenesis in the three families of Enterpneusta. It is suggested that the duration of larval life is a factor influencing the spatial distribution of a given species. Larval life is short in the present species (9 days) compared to *Ptychodera flava* (45) days in the same locality.

32. **Daniel, A.**: *On a new barnacle pollicipes polymerus madrasensis sub-sp. nov. in Madras*: **Ann. Mag. Nat. Hist., 6: 286-287, 1953.**

A new variety of *Pollicipes polymerus* is described.

33. **Ramamurthy, S.**: *Seasonal changes in the Hydrogen-ion concentrations and dissolved Oxygen content of the surface waters of the Madras coast*: **J. Madras Univ., B. 23: 52-60, 1953.**

Measurements of temperature, salinity, pH and dissolved oxygen in the surface waters of the Madras coast made during the period February 1951 to April 1952 are reported. The seasonal variations of pH, dissolved oxygen are discussed with reference to temperature, salinity and also diatom variation on the basis of mean monthly values. pH is shown to be independent of changes in oxygen content and is probably dependent on the carbon-di-oxide content which is affected by photosynthesis. The oxygen content is found to be influenced by water temperature rather than by photo-synthetic activity.

34. **Ramamurthy, S.**: *Hydrobiological studies in the Madras coastal waters*: **Ibid., 23: 148-163, 1953.**

A review of the work on hydrology and plankton in Indian waters is given. Measurements of temperature, salinity, pH, dissolved oxygen, phosphates, nitrites and silicates in the surface waters of the Madras coast are presented. Observations on the seasonal fluctuations of the zooplankton and the phytoplankton are also given. The possible relationships between the diatoms and the available physico-chemical factors are discussed. The occurrence of the zooplankton and its main components is considered in relation to certain of the hydrographical factors, also in relation to diatoms.

A programme of study of the vertical distribution of physico-chemical conditions and the plankton in the Madras coast is given and the results of the determinations of transparency, temperature, salinity, pH, dissolved oxygen, phosphates, nitrites and silicates during the visits for the period Sept. 1952 to April 1953 are tabulated.

35. **Ramamurthy, S.:** *Measurement of Diatom population by pigment extraction method:* **Ibid., 164-173, 1953.**

Quantitative estimates of diatoms in the tow-net collections of mixed phytoplankton and zooplankton made by Harvey's pigment extraction method and cell census method during the period '51 April—'52 April and December '52—April '53, are presented. The results obtained are compared and discussed.

36. **Krishnaswamy, S.:** *Pelagic copepoda of the Madras coast*: **J. Madras Univ., B. 23: 61-75, 1953.**

Reports 27 species of cyclopoids, based on a detailed study of over 250 samples of plankton collected at Krusadai Is. as well as Madras. A species of *Monstrilla* and two species of *Caligus* are also recorded.

37. **Krishnaswamy, S.:** *Pelagic copepod of the Madras Coast*: **Ibid., 104-144, 1953.**

Reports 69 species of Calanoids collected at Madras and Krusadai Is, in the Gulf of Mannar. The environmental differences found in *Labidocera kroyeri* (Brady) collected from different localities are described.

38. **Vijayaraghavan, P.:** *Food of the Sardines of Madras Coast*: **J. Madras Univ., B. 23: 29-30, 1953.**

Stomach contents of 189 specimens of *Sardinella brachysoma,* 248 *S. kanagurta* and 324 *S. melanura* were analysed of which the latter was divided into two size groups according to their size and the difference in their diet discussed. While there are indications of particulate as well as filter feeding, the sardines are found to be filter feeders. That to some extent they are capable of selective feeding is shown by the total absence of teleosteans and the predominance of crustaceans in their diet. The absence of this species in certain months of the year cannot be explained until we know more about their migratory habits and also the seasonal distribution of the food organisms in the environment.

Madras University: Department of Bio-Chemistry

Abstracts of Papers Published, 1950-53

1950

1. **Visvanathan, R.:** *Preparation and properties of β dextrin from arrow root starch*: **J. sci. industr. Res., 9**: 285, 1950.

The preparation of β dextrin from soluble starch (arrow root) under different experimental conditions has been described. The phosphorous content, copper reducing power, iodine number and rates of hydrolysis by malt amylase have been determined.

1951

2. **Sivasankar, D. V.** and **Sarma, P. S.:** *Biotin and its replacement by fatty acid*: **J. sci. industr. Res., 10(B)**: 3, 1951.

The influence of d-biotin on the growth of the Rice moth larve (*Corcyra cephalonica st.*) and *Neurospora crassa* and its replacement by oleic and vaccenic acids in their nutrition have been investigated. The possibilty of assaying the vitamin biotin, employing rice moth larva has been indicated.

3. **Ramachandran, L. K.** and **Sarma, P. S.:** *Periodate oxidation of dyestuffs containing the hydroquinone grouping*: **J. sci. industr. Res., 10(B)**: 147, 1951.

The use of periodate in the oxidation of certain dyestuffs containing the hydroquinone grouping is discussed.

4. **Sarma, P. S.** and **Sivasankar, D. V.:** *Human Nutrition*: **Ann. Rev. of Biochemical and Allied Researches in India: 21**: 35, 1951.

The work carried out in the metabolism vitamins, amino acids and fats by various workers in India during the year 1950 is reviewed.

5. **Ramachandran, L. K.** and **Sarma, P. S.:** *Colorimetric determination of tyrosine*: **J. sci. industr. Res., 10(B)**: 246, 1951.

The specific colour forming reaction between non-ortho-substituted p-alkyl phenols 1, 2, nitroso-naphthol and nitric acid has been made the basis of a sensitive and accurate method for the determination of tyrosine in proteins. The method can be used for the estimation of free tyrosine in iodinated protein preparations.

6. **Sivasankar, D. V.** and **Sarma, P. S.:** *Studies on Biotin—Part I. Replacement of Biotin in the nutrition of rice moth larva (Corcyra cephalonica st.)*: **J. sci. industr. Res., 10(B)** : 294, 1951.

The role of biotin in the nutrition of rice moth larva and the replacement of biotin by oleic acid have been investigated. Large amount of fat, and cholesterol are synthesised by biotin-fed larva than by biotin deficient larva. It is found that biotin is a necessary dietary constituent and plays an important role in the conversion of dietary fat to body fat.

7. **Ramachandran, M.** and **Sarma, P. S.:** *Ionophoretic separation of methionine*: **Curr, Sci., 20:** 39, 1951.

During ionophoresis of acid hydrolised casein, an appreciable amount of methionine was found to migrate to only cathode. The use of ionophoretic method in the separation of amino acids is discussed.

8. **Ramachandran, M.:** *The Liberation of tryptophan during enzymic proteolysis*: **J. Madras Univ. B. 21:** 321, 1951.

The liberation of tryptophan during the successive action of pepsin, trypsin and erepsin on the three different proteins casein, edestin and blood fibrin has been studied in detail. The percent peptide split, the apparent and free tryptophan are estimated throughout the series of enzymic digestions.

9. **Shanmugasundaram, E. R. B., Ranganathan, G.** and **Sarma, P. S.:** *Studies on the inter-relationship among some vitamins and amino acids—Influence of Desoxy-pyridoxine on the biosynthesis of nicotinic and ascorbic acids in germinating pulses*: **Curr. Sci., 20:** 122, 1951.

It is found that during germination of pulses in a medium containing desoxy-pyridoxine—the antivitamin for pyridoxine, the biosynthesis of nicotinic and ascorbic acids were reduced. However, the deleterious effect was overcome by the addition of excess pyridoxine, showing thereby that pyridoxine is concerned in the biosynthesis of nicotinic and ascorbic acids during germination.

10. **Sivaramakrishnan, V. M.** and **Sarma, P. S.:** *Sulphur distribution in red milo (Sorghum vulgare)*: **J. Madras Univ. B. 21:** 75, 1951.

The sulphur distribution in Milo and Milo prolamin has been investigated. The presence of large amount of bromine oxidisable sulphur is shown. The possible presence of an unidentified sulphur constituent is discussed.

11. **Ramachandran, L. K.** and **Sarma, P. S.:** *Isolation of methionine by ionophoretic fractionation of protein hydrolysates*: **J. Madras Univ. B. 21:** 118, 1951.

A method for the isolation of methionine from protein hydrolysates, based on the addition of electrolytes like NaCl which results in the maximum migration of methionine to the cathode chamber and subsequent separation from hexone bases by exchange on permutit is presented.

1952.

12. **Sivasankar, D. V., Tirunarayanan, M. O.** and **Sarma, P. S.:** *Studies on biotin—Part II. Amino acid deamination and fat formation in Neurospora*: **J. sci. industr. Res., 11(B):** 63, 1952.

The role of biotin in the nutrition and metabolism of a cholineless mutant of *Neurospora crassa* and the replaceability of biotin by fatty acids have been investigated. Mycelia from biotin supplemented medium deaminate amino acids 1 to 4 times better than mycelia obtained from biotin deficient medium.

13. **Sivasankar, D. V.** *and* **Sarma, P. S.:** *Studies on biotin—Part III. Physiological aspects of biotin deficiency in the rat*: **J. sci., industr. Res., 11(B):** 122, 1952.

During biotin deficiency, there is increased retention of nitrogen, and decreased excretion of urea, in the rat. Experiments reveal that biotin may have a role in the desaturation of saturated fatty acids and that biotin deficiency impairs nitrogen metabolism.

14. **Sivasankar, D. V.** and **Sarma, P. S.:** *Studies on biotin—Part IV*: *Uric acid excretion in the rice moth larva* (*Corcyra cephalonica st.*); **J. sci. industr. Res., 11 (B):** 395, 1952.

In larvae fed biotin, there is increased formation of fat and greater utilisation of protein nitrogen and carbohydrate. Uric acid excretion decreases when larvae are fed biotin deficient diet.

15. **Radhakrishnamurthy, R.** and **Sarma, P. S.:** *A modification in the paper chromatographic technique of sugars and amino acids*: **J. sci. industr. Res., 11(B):** 278, 1952.

A simple device consisting of a pad of filter paper discs, to provide extra capillary absorption in ascending chromatography of sugars and amino acids is described.

16. **Ramachandran, L. K.** and **Sarma, P. S.:** *Action of Iodine on tryptophane*: **J. sci. industr. Res., 11(B):** 161, 1952.

The action of iodine with tryptophane has been quantitatively studied. The formation of iodinated derivative is not observed and the reaction is found to be oxidative in character. In bicarbonate medium pH (8·1) 8 atoms of iodine and in phosphate medium pH (8·1) 9 atoms of iodine are found to be used up.

17. **Ramachandran, L. K.** and **Sarma, P. S.:** *The liberation of serine and threonine during proteolysis*: **J. sci. Res., 11(B):** 379, 1952.

The course and extent of liberation of serine and threonine during the hydrolysis of casein, edestin, egg albumin, fibrin and gliadin, when hydrolysed with pepsin, trypsin, and erepsin and HCN—activated papain have been investigated.

18. **Sivasankar, D. V.:** *Proteins and other nitrogenous constituents of the castor seed; Part I*: **J. Indian chem. Soc. 15:** 45, 1952.

A preliminary study to find out the distribution of nitrogen in the castor seed is made.

19. **Sivasankar, D. V.:** *Proteins and other nitrogenous constituents of the castor seed; Part II*: **J. Indian chem. Soc. 15:** 49, 1952.

Methods used for the fractionation of the protein constituents are discussed.

20. **Sivasankar, D. V.:** *Proteins and other nitrogenous constituents of the castor seed; Part III*: **J. Indian chem. Soc. 15:** 55, 1952.

Individual protein constituents, their purification, properties and analysis are discussed.

21. **Ramachandran, L. K.:** *The effect of N′ and O′-acylation on the periodate oxidation of hydroxy lysine*: **J. Madras Univ. B. 22:** 76, 1952.

It is found that N′—benzoylation and O′—acylation effectively inhibits the periodate oxidation of hydroxy lysine. Benzoylation masks the specific groups of hydroxy lysine and prevents oxidation by periodate.

22. **Ramachandran, L. K.** and **Sarma, P. S.:** *The isolation of the 2, 4 dinitro phenyl hydrazone of glutamic acid semi aldehyde from the acid hydrolysate of periodate treated gelatin*: **Curr, Sci. 21:** 3, 1952.

The isolation of 2, 4, dinitro phenyl hydrazone by periodate oxidation of hydroxylysine (1, 6-diamino-5 hydroxy caproic acid) is described.

23. **Ramachandran, L. K.** and **Sarma, P. S.:** *Error involved in the gravimetric determination of lysine in the presence of hydroxy lysine*: **Curr. Sci. 21:** 280, 1952.

The presence of hydroxy-lysine is found to lower the accuracy of the original method of estimation of lysine using benzilidine reagent and styphynic acid. The indiscriminate use of the general method to determine lysine in materials containing hydroxy lysine will, therefore, give erroneous results.

24. **Shanmugasundaram, E. R. B.** and **Sarma, P. S.:** *Studies on the inter-relationship among some vitamins and amino acids*

—*Invitro studies of the influence of desoxy pyridoxine on the conversion of tryptophane to nicotinic acid:* **J. Madras Univ. B., 22:** 84, 1952.

It has been shown using the antivitamin of pyridoxine—desoxy pyridoxine —in the case of rat and cattle liver slices, that pyridoxine added, as well as, that already present influences the biosynthesis of nicotinic acid. The D-isomer of tryptophane is found to inhibit the normal synthesis of nicotinic acid.

25. **Ramachandran, L. K.:** *Plant tumours versus animal tumours —a review:* **J. Madras Univ. B. 22:** 268, 1952.

A review in which certain aspects of animal tumours are dealt with in comparison with plant tumours.

1953

26. **Ramachandran, L. K.** and **Sarma, P. S.:** *A new method for the isolation of hydroxy lysine:* **J. Sci. industr. Res. 12(B):** 4, 1953.

A new method for the isolation of hydroxy lysine based on the intermediate formation of a cyclic oxazoline derivative of the amino acid when condensed with benzimino-ethyl ether is reported. Problems associated with the isolation of this amino acid are discussed.

27. **Ramachandran, L. K.:** *The determination of hydroxy lysine in proteins:* **J. Sci. industr. Res. 12(B):** 9, 1953.

A method for the determination of hydroxy lysine in intact proteins, based on the measurement of the ammonia evolved on periodate oxidation is described.

28. **Shanmugasundaram, E. R. B.** and **Sarma, P. S.:** *Studies on the inter-relationship among some vitamins and amino acids Part I. Synthesis of Nicotinic acid from the isomers of tryptophane by mammalian liver slices and germinating green-gram.* **J. sci. industr. Res., 12(B):** 245, 1953.

Invitro experiments on the livers of rat, rabbit, and cattle have shown that the rat liver synthesises nicotinic acid from D-tryptophane, whereas cattle and rabbit livers do not, and at higher levels the D-isomer inhibits the normal synthesis of nicotinic acid. The utilisation of the D-isomer was ascribed to the enzyme D-amino-acid oxidase. The observations in the case of germinating green-gram are similar to cattle and rabbit livers.

29. **Sivaramakrishnan, V. M.** and **Sarma, P. S.:** *The influence of vitamins on nitrogen metabolism—Part I. The influence of PABA, sulphanilamide and folic acid on amino acid changes during germination:* **J. sci. industr. Res., 12(B):** 157, 1953.

The changes produced by sulphanilamide in amino acid levels during germination and counteracting effects of PABA and folic acid have been studied. Both folic acid and PABA are involved in serine and methionine metabolism and a metabolic relationship between methionine and histidine is suggested.

30. **Tirunarayanan, M. O.** and **Sarma, P. S.:** *Studies on biotin—Part V. Influence of biotin on the Gammexane-inositol relationship in Neurospora crassa:* **J. sci. industr. Res., 12(B): 251, 1953.**

Evidence is presented to show that biotin is involved in reversing growth inhibition due to gamma isomer of hexachloro cyclohexane in a wild strain of *N. Crassa.* Other vitamins of "B" group do not affect the growth of the organism in the presence or absence of the gamma isomer. The possible effect of biotin is discussed.

31. **Ramachandran, L. K.** and **Sarma, P. S.:** *The reactivity of phenolic groups in Egg albumin towards iodine:* **J. Sci. industr. Res. 12(B):** 309, 1953.

Studies on the reactivity and availability of tyrosine groups in egg albumin at pH 5 in phosphate buffer at 37°C have shown that nearly 30% of the groups remained unavailable for iodination. Phosphate exerts a marked catalytic action on the process of iodination of tyrosine groups in native egg albumin, probably by activating certain groups.

32. **Sivaramakrishnan, V. M.** and **Sarma, P. S.:** *Inhibition analysis —a review with reference to B Vitamins:* **J. Madras Univ. 23(B):** 40, 1953.

A brief but detailed account of the study of the role of certain B vitamins in biological reactions with the aid of antivitamins is presented.

33. **Radhakrishnamurthy, R.** and **Sarma, P. S.:** *Paper chromatographic separation of "B" group vitamins:* **Curr. Sci. 22:** 209, **1953.**

A method for the successful separation and identification of individual vitamins from a mixture of "B" vitamins, containing B_1, B_2, Nicotinic acid and amide, choline, inositol, B_6, B_{12}, calcium pantothenate and PABA has been worked out.

34. **Shanmugasundaram, E. R. B., Tirunarayanan, M. O.** and **Sarma, P. S.:** *Role of biotin in the conversion of tryptophane to nicotinic acid:* **Curr. Sci. 22:** 211, 1953.

The utilisation of tryptophane by a nicotinic acid requiring mutant of *N. Crassa* is found to be affected by the presence of γ, 3: 4 (Ureylene cyclohexl)-butyric acid, an antimetabolite of biotin. The deleterious effect was overcome by the addition of biotin showing that biotin is involved in the

conversion of tryptophane to nicotinic acid. Similar observations are noticed in germinating green gram.

35. **Sundaram, T. K.** and **Sarma, P. S.**: *Trytophane metabolism in rice moth larva (Corcyra cephalonica st.)*: **Nature, 172:** 627, 1953.

Studies on the chemical identity of the yellow pigment metabolites of tryptophane excreted by rice moth larva in B_6 deficiency, by chromatographic technique, reveal the presence of kynurenine, and 3-hydroxy kynurenine and absence of xanthurenic acid. The metabolism of D-tryptophan is also investigated.

36. **Sundararajan, T. A.** and **Sarma, P. S.**: *Distribution of phospho-protein phosphatase in mammalian tissues*: **Curr. Sci.** (in press).

The distribution of phosphoprotein phosphatases in several mamalian tissues has been studied.

37. **Moudgal, N. R., Ramachandran, L. K.** and **Sarma, P. S.**: *Colorimetric determination of 3 : 5 diiodo tyrosine*, **Analyst**, (in press).

A colorimetric method for determining 3:5 diiodo tyrosine in hydrolysates of iodo proteins is described. The method depends on the formation of a coloured metal complex with cobalt and is specific for diiodotyrosine.

38. **Sundararajan, T. A.** and **Sarma, P. S.**: *Purification and properties of phosphoprotein phosphatase from ox-spleen*, **Biochem. J.** (in press).

Phosphoprotein, phosphatases, an enzyme specific for the dephosphorylation of phosphoproteins has been purified from ox spleen and its various properties have been studied.

39. **Shanmugasundaram, E. R. B.** *and* **Sarma, P. S.**: *Studies on the inter-relationship among some vitamins and amino acids —Part II; influence of γ : 3 : 4 (ureylene cyclohexyl)-butyric acid, aminopterin and w-methyl pantothenic acid in the biosynthesis of nicotinic acid in germinating green gram*: **J. sci. industr. Res.** (in press).

Using γ, 3: 4 (ureylene cyclohexyl)-butyric acid, the anti biotin compound, and aminopterin the anti folic acid compound, it is shown that biotin and folic acid are concerned in the conversion of tryptophane to nicotinic acid. Pantothenic acid has no influence.

40. **Sundaram, T. K., Radhakrishnamurthy, R., Shanmugasundaram, E. R. B.,** and **Sarma, P. S.**: *Tryptophane metabolism of*

rice moth larva studied by circular paper chromatography: **Proc. Soc. Expt. Biol. & Med.**, (in press).

The technique of circular paper chromatography has been adapted to the investigation of trytophane metabolism in rice moth larva (*Corcyra cephalonica st.*).

41. **Ramachandran, S.** and **Sarma, P. S.**: *Role of inositol in the activity of alpha amylase*: **Indian J. Med. Res.** (in press).

Inositol-deficiency has been produced in rats, rabbits, and rice moth larvae and it is shown that in this deficiency state there is a lowering of amylase activity. This inhibition is reversed by inositol.

42. **Friedmann, H. C.** and **Sarma, P. S.**: *Adenosine Triphosphate Breakdown by liver extracts*: **J. Madras Univ. B. 23:** (3) ,1953 (in press).

Investigations on Adenosine Triphosphate breakdown by liver extracts of different animals have been carried out with a due appreciation of the errors involved.

Madras University: Department of Organic Chemistry

Abstracts of Papers Published, 1951-53

1. **Menon, K. N.** and **Venkitasubramanian, T. A.:** *Fatty acids and Glyceride composition of Sesamum indicum*: **J. Madras Univ. B. 21:** 272, 1951.

A sample of cold pressed sesame oil, examined by Bertram's oxidation method, was found to contain palmitic acid 10·2, stearic 5.7, oleic 45·9 and linoleic 38·2 per cent by molecules. The specimen contained traces of GS_3, 15·1 of GS_2U, 17·5 of GSU_2 and 67·3 of GU_3 in per cent by molecules.

2. **Sundara Rajan, N. S.:** *A short Review of the Chemistry of Coumaran-3-ones*: **J. Madras Univ. B. 22:** 129, 1952.

A comprehensive review of coumaran-3-ones dealing with preparation, properties, reactions, 2-alkyl coumaranones, benzal coumaranones, halogeno, coumaranones and coumarano-indoles.

3. **Subbaram, M. R.:** *Glyceride composition of the seed fat of Cerbera odollam (Gaertn).* **J. Madras Univ. B. 22:** 223, 1952.

The seeds of Cerbera odollam contain 62·1% of a pale yellow oil. The component acids are stearic 10·8%, palmitic 32%, oleic 38·8% and linoleic acid 18·4% by weight. The molecular proportion of the acids are stearic 10·3, palmitic 34·1, oleic 37·6 and linoleic 18 per cent. The distribution of Glycerides in the sample on investigation by the tentative Oxidation method was found to be as follows: GS_3 traces, GS_2U 51·1, GSU_2 31·0 and GU_3 17·9 per cent by molecules.

4. **Menon, K. N.:** *Isomerisation of Bicyclic Terpenes*: **J. Madras Univ. B. 23:** 92, 1953.

The mechanism of the following have been explained:—(a) conversion of Camphene to p-Cymene, (b) formation of 1-ethyl-2-isopropyl-cyclopentene from pinene, (c) formation of 1:2-dimethyl-3-isopropyl-cyclopentane from thujene and (d) formation of an allylic-chloro-derivative from 3-carne.

Madras University: Department of Physics

Abstracts of Papers Published, 1952-53

I. CRYSTALLOGRAPHY

1. **Ramaseshan, S.** and **Ramachandran, G. N.:** *Influence of mosaicity on the Bragg reflection of polarized x-rays,* **Acta Crystallographica: 6:** 364, 1953.

Using completely polarized x-rays for study, it is shown that the variation of the integrated reflection with the azimuth of polarization is different for a perfect crystal and for a mosaic crystal. Such a difference is to be expected from theory and making use of such measurements, it is possible to assess the degree of perfection of a crystal.

2. **Ramachandran, G. N.:** *The Poincare Sphere and Stokes Parameters:* **J. Madras Univ. B. 22:** 277, 1952.

The representation originally suggested by Poincare can be extended so that any state of polarisation of a light beam (including partial polarisation) may be represented by a point inside a sphere of unit radius. Then the resolved components along suitable axes of the vector joining the centre to this point, multiplied by the intensity (I) of the beam, are the three Stokes parameters M.C.S. Various theorems on Stokes paramters can be derived very simply, using this representation. It is shown that the mean degree of polarisation always decreases when two beams are superposed incoherently, being a constant only when the states of the polarised components of the two are the same. The Poincare representation is used to discuss the theory of a monochromatic depolariser and more general conditions are derived than those indicated earlier by Billings.

II. ASTROPHYSICS

1. **Alladi Ramakrishnan:** *On an integral equation of Chandrasekhar and Munch:* **Astrophysical J., 115:** 143, 1952.

This paper deals with a new and easier method of derivation of the integral equation of Chandrasekhar and Munch relating to the fluctuations in brightness of the Milky Way.

2. **Alladi Ramakrishnan** and **Mathews, P. M.:** *The solution of an integral equation of Chandrasekhar and Munch*: **Astrophysical J.** (in press).

This paper deals with a new method of solution of the integral equations of Chandrasekhar and Munch in relation to the astrophysical problem mentioned above.

3. **Alladi Ramakrishnan:** *A stochastic model of a fluctuating density field I..* **Astrophysical J.** (in press).

This deals with the development of a mathematical model of a fluctuating density field first introduced by Chandrasekhar and Munch in their

recent papers in the Astrophysical Journal. Some of Chandrasekhar's results have been extended.

III. CASCADE THEORY

1. **Alladi Ramakrishnan:** *On Janossy's mathematical model of a nucleon cascade*: **Proc. Camb. Phil. Soc., 48:** 451, 1952.

This is an application of the theory of product-densities developed in an earlier contribution to the same Journal to the problem of nucleon cascades.

2. **Alladi Ramakrishnan** and **Mathews, P. M.:** *Numerical work on the fluctuation problem of electron cascades*: **Progress of Theoretical Physics (Japan),** (in press).

3. **Alladi Ramakrishnan** and **Mathews, P. M.:** *Studies on the fluctuation problem of electron cascades*: **Progress of Theoretical Physics (Japan),** (in press).

The above two papers deal with the latest numerical calculations on the well known fluctuation problem of cosmic radiation. These calculations are based on the earlier paper of Bhabha and Ramakrishnan on the same problem. The numerical results are tabulated and form a sequel to those of Bhabha and Chakrabarthy—(*Proc. Roy. Soc.* A—181 (1942), 267.)

IV. GENERAL

1. **Alladi Ramakrishnan** and **Mathews, P. M.:** *A stochastic problem relating to Counters*: **Philosphical Magazine 44:** 1122, 1953.

This deals with the complete solution of a hitherto unsolved problem relating to counters with two different dead times.

2. **Alladi Ramakrishnan:** *On a class of stochastic processes associated with the random division of a line*: **Proc. Camb. Phil. Soc., 49:** 473, 1953.

This paper deals with a class of stochastic processes associated with points randomly distributed in a line of finite extension. A general integral equation for the function representing the probability distribution of the stochastic variable under consideration is derived and solved by the use of the Laplace Transform technique. Examples of the above class of stochastic processes are cited. In particular, the problem of the fluctuations in brightness of the Milky Way is discussed in detail. The results of Chandrasekhar and Munch are derived in a simple and direct manner.

3. **Alladi Ramakrishnan** and **Mathews, P. M.:** *On a class of stochastic integro-differential equations*: **Proc. Indian Acad. Sci. A** (in press).

This paper deals with a class of stochastic processes involving deterministic changes in the statistical variable in addition to possible random transitions. Examples are cited from physics and physical chemistry.

Madras University: Department of Mathematics

Abstracts of Papers Published, 1952-53

1. **Krishnan, V. S.:** *On uniconvergence spaces*: **J. Madras Univ. B. 23: 174-181, 1953.**

For metrisable spaces there is a simple theory of convergence (of sequences) which sufficies to characterise the topology of the space. For more general spaces it is known that convergences of sets of points indexed by various directed sets would be necessary to give a complete characterisation of the topology in terms of convergence. For the uniform spaces it is reasonable to expect that some simpler convergence approach should be possible. It is shown here that using a basic family of convergences of point sets all indexed by a fixed directed set one can specify not only the topology but also the uniform structure of a uniform space. The passage from such a *uniconvergence* scheme to a uniform structure and vice-versa is worked out. Other questions regarding compactness, completeness etc., will be treated in subsequent papers.

2. **Krishnan, V. S.:** *Closure operations on c-structures*: **Proc. Konig. Neder. Akad. v. Weten.** (in press).

In an earlier paper (Bull. Soc. Math. de France, 79,1951) an axiomatic theory was developed to sudy the structural features common to partially ordered sets and topological spaces, in particular regarding the possibility of sub direct product representations. This paper extends the study to more complex structures, roughly algebraic structures with a superposed partial order or topology. The axioms involve as primitive concepts the *b-structures* (the algebraic base in the applications) the *c-structures* (the ordered or topologised algebra) and certain distinguished transformations between these (corresponding to the algebraic homomorphisms and the order-preserving or continuous homomorphisms). In terms of these primitive concepts definitions are given of substructures, of direct products, of finer and coarser structures over the same point set, and of limits of inverse directed classes. Interrelations between representations of different sorts are worked out. As applications are treated the following structures: the distributive lattice, the regular 1-group, the completely regular space, the uniform space, and the compact topological group.

3. **Balachandran, V. K.:** *On Disjunction Lattices*: **J. Madras Univ. B. 23: 15-21, 1953.**

Two new charaterizations for disjunction lattices or distributive lattices satisfying Wallman disjunction property are given. They are:—

(1) A distributive lattice is a disjunction lattice, if any only if, every principal μ-ideal is normal.

(2) A lattice is a disjunction lattice, if and only if, every principal μ-ideal is a product of minimal prime μ-ideals.

Using these results some characterizations for Boolean algebras as special disjunction lattices are obtained. One of these, which is related to (2) may be stated:

(2′) A lattice closed for product-complements is a Boolean algebra, if and only if, it satisfies the condition stated under (2).

Finally, the connection of the present results on Boolean algebras to an earlier result of the author, as well as that to a theorem of Michiura are pointed out.

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